Proceedings of the I·R·E

Illinois U Library

A Journal of Communications and Electronic Engineering

December, 1950

Volume 38 Number 12

For further details see pages 1458 and 1459.

PROCEEDINGS OF THE I.R.E.

Periodical Literature for Electronic Engineers

Practical Design for Production and Quality

Graphical Analysis of Transistor Characteristics

Reactance Chart

Inductance Chart for Solenoid Coil

Transmission-Line Impedance Curves

The Simplification of Television Receivers

Design Curves for IF Amplifiers

Marginal Checking for Computer Reliability

A Digital Electronic Correlator

Split-Anode Magnetron Operation

Frequency Characteristics of Magnetrons

Tropospheric Reception (Abstract)

Abstracts and References

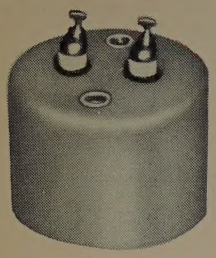
Annual Index

TABLE OF CONTENTS, INDICATED BY BLACK-AND-WHITE MARGIN, FOLLOWS PAGE 32A

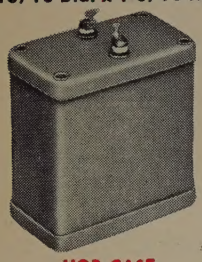
The Institute of Radio Engineers

PERMALLOY DUST TOROIDS FOR MAXIMUM STABILITY...

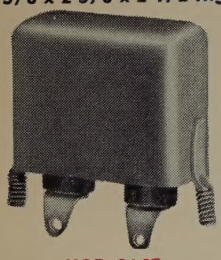
The UTC type HQ permalloy dust toroids are ideal for all audio, carrier and supersonic applications. HQA coils have Q over 100 at 5,000 cycles... HQB coils, Q over 200 at 4,000 cycles... HQC coils, Q over 200 at 30 KC... HQD coils, Q over 200 at 60 KC... HQE (miniature) coils, Q over 120 at 10 KC. The toroid dust core provides very low hum pickup... excellent stability with voltage change... negligible inductance change with temperature, etc. Precision adjusted to 1% tolerance. Hermetically sealed.



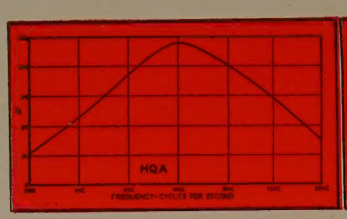
HQA, HQC, HQD CASE
1 13/16"Dia. x 1 3/16"High

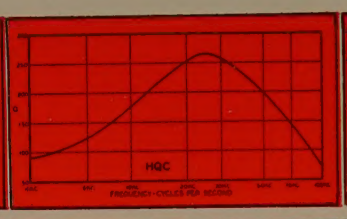


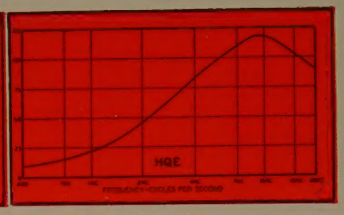
HQB CASE
1 5/8"x 2 5/8"x 2 1/2"High

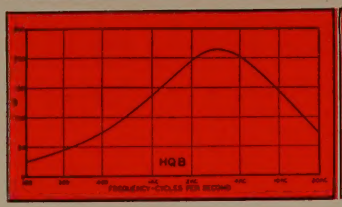


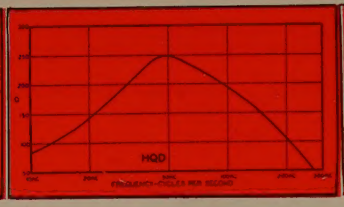
HQE CASE
1/2"x 1 5/16"x 1 3/16"High

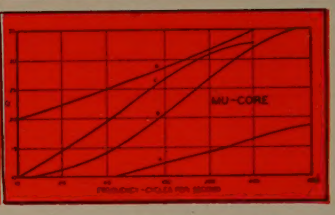










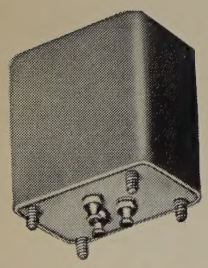


Type No.	Inductance Value	Net Price
HQA-1	5 mhy.	$7.00
HQA-2	12.5 mhy.	7.00
HQA-3	20 mhy.	7.50
HQA-4	30 mhy.	7.50
HQA-5	50 mhy.	8.00
HQA-6	80 mhy.	8.00
HQA-7	125 mhy.	9.00
HQA-8	200 mhy.	9.00
HQA-9	300 mhy.	10.00
HQA-10	.5 hy.	10.00
HQA-11	.75 hy.	10.00
HQA-12	1.25 hy.	11.00
HQA-13	2. hy.	11.00
HQA-14	3. hy.	13.00
HQA-15	5. hy.	14.00

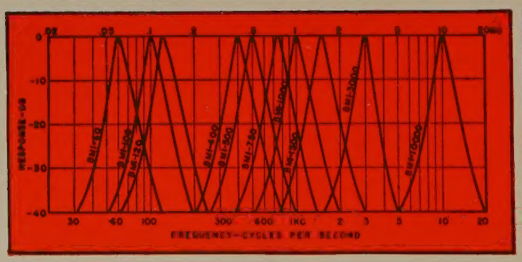
Type No.	Inductance Value	Net Price
HQA-16	7.5 hy.	$15.00
HQA-17	10. hy.	16.00
HQA-18	15. hy.	17.00
HQB-1	10 mhy.	16.00
HQB-2	30 mhy.	16.00
HQB-3	70 mhy.	16.00
HQB-4	120 mhy.	17.00
HQB-5	.5 hy.	17.00
HQB-6	1. hy.	18.00
HQB-7	2. hy.	19.00
HQB-8	3.5 hy.	20.00
HQB-9	7.5 hy.	21.00
HQB-10	12. hy.	22.00
HQB-11	18. hy.	23.00
HQB-12	25. hy.	24.00

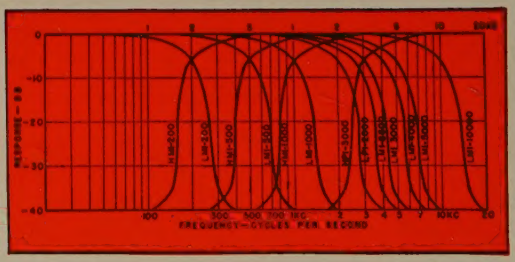
Type No.	Inductance Value	Net Price
HQC-1	1 mhy.	$13.00
HQC-2	2.5 mhy.	13.00
HQC-3	5 mhy.	13.00
HQC-4	10 mhy.	13.00
HQC-5	20 mhy.	13.00
HQD-1	.4 mhy.	15.00
HQD-2	1 mhy.	15.00
HQD-3	2.5 mhy.	15.00
HQD-4	5 mhy.	15.00
HQD-5	15 mhy.	15.00
HQE-1	5 mhy.	6.00
HQE-2	10 mhy.	6.00
HQE-3	50 mhy.	7.00
HQE-4	100 mhy.	7.50
HQE-5	200 mhy.	8.00

UTC INTERSTAGE AND LINE FILTERS



FILTER CASE M
1 3/16"x 1 11/16",
1 5/8"- 2 1/2"High





These U.T.C. stock units take care of most common filter applications. The interstage filters, BMI (band pass), HMI (high pass), and LMI (low pass), have a nominal impedance at 10,000 ohms. The line filters, BML (band pass), HML (high pass), and LML (low pass), are intended for use in 500/600 ohm circuits. All units are shielded for low pickup (150 mv/gauss) and are hermetically sealed.

STOCK FREQUENCIES
(Number after letters is frequency)
Net Price $25.00

BMI-60	BMI-1500	LMI-200	BML-400
BMI-100	BMI-3000	LMI-500	BML-1000
BMI-120	BMI-10000	LMI-1000	HML-200
BMI-400	HMI-200	LMI-2000	HML-500
BMI-500	HMI-500	LMI-3000	LML-1000
BMI-750	HMI-1000	LMI-5000	LML-2500
BMI-1000	HMI-3000	LMI-10000	LML-4000
			LML-12000

United Transformer Co.
150 VARICK STREET NEW YORK 13, N. Y.
EXPORT DIVISION: 13 EAST 40th STREET NEW YORK 16, N. Y. CABLES: "ARLAB"

BOARD OF DIRECTORS, 1950*

Raymond F. Guy
President

R. A. Watson-Watt
Vice-President

D. B. Sinclair
Treasurer

Haraden Pratt
Secretary

Alfred N. Goldsmith
Editor

B. E. Shackelford
Senior Past President

Stuart L Bailey
Junior Past President

1950

Ben Akerman (6)
W. R. G. Baker
T. H. Clark
J. V. L. Hogan (2)
T. A. Hunter
H. E. Kranz (4)
F. H R. Pounsett (8)
J. E Shepherd
J. A. Stratton

1950–1951

A. V. Eastman (7)
W. L. Everitt
D. G. Fink
F. Hamburger, Jr. (3)
H. J. Reich (1)
J. D. Reid (5)

1950–1952

W. R. Hewlett
J. W. McRae

●

Harold R. Zeamans
General Counsel

●

George W Bailey
Executive Secretary

Laurence G. Cumming
Technical Secretary

●

Changes of address (with advance notice of fifteen days) and communications regarding subscriptions and payments should be mailed to the Secretary of the Institute, at 450 Ahnaip St., Menasha, Wisconsin, or 1 East 79 Street, New York 21, N. Y.

All rights of republication, including translation into foreign languages, are reserved by the Institute. Abstracts of papers with mention of their source, may be printed. Requests for republication privileges should be addressed to The Institute of Radio Engineers.

* Numerals in parenthesis following Directors' names designate Region number.

PROCEEDINGS OF THE I.R.E.

Published Monthly by

The Institute of Radio Engineers, Inc.

VOLUME 38 — *December, 1950* — NUMBER 12

PROCEEDINGS OF THE I.R.E.

W. R. G. Baker 1378
A Half Century ..... Lee de Forest 1379
3779. Periodical Literature for Electronic Engineers ..... R C. Coile 1380
3780 Practical Design for Effective Production and High Quality ..... Joseph Manuele 1385
3781. Graphical Analysis of Transistor Characteristics ..... Lloyd P. Hunter 1387
3782. Reactance Chart ..... Harold A. Wheeler 1392
3783. Inductance Chart for Solenoid Coil ..... Harold A. Wheeler 1398
3784. Transmission-Line Impedance Curves ..... Harold A. Wheeler 1400
3785. The Simplification of Television Receivers ..... W. B. Whalley 1404
3786. Universal Design Curves for Intermediate-Frequency Amplifiers with Particular Reference to Phase and Amplitude Distortion and Their Compensation ..... W. Hackett 1408
3787. Marginal Checking as an Aid to Computer Reliability ..... Norman H. Taylor 1418
3788. A Digital Electronic Correlator ..... Henry E. Singleton 1422
3789. Some Aspects of Split-Anode Magnetron Operation ..... H. J. Reich, J. C. May, J. G. Skalnik, and R. L. Ungvary 1428
3790. Effects of Space Charge on Frequency Characteristics of Magnetrons ..... H. W Welch, Jr. 1434
3791. Comparison of Tropospheric Reception at 44.1 Mc with 92.1 Mc Over the 167-Mile Path of Alpine, New Jersey, to Needham, Massachusetts ..... Greenleaf W. Pickard and Harlan T. Stetson 1450
Contributors to the PROCEEDINGS OF THE I.R.E. 1451
Correspondence:
3792. Reflected Ray Suppression ..... Howard E. Bussey 1453
3793. A Note on the Synthesis of Resistor-Capacitor Network ..... Charles Belove 1453
3794. Relation of Nyquist Diagram to Pole-Zero Plots in the Complex Frequency Plane ..... W. W Harman 1454
3795. Elliptically Polarized Waves ..... Leonard Hatkin 1455
3796. An Achromatic Microwave Antenna ..... N. I. Korman and J. R. Ford 1455
3797. Stratospheric-Ionospheric Relationships ..... N. C. Gerson 1456

INSTITUTE NEWS AND RADIO NOTES SECTION

25 Years of IRE in Canada 1458
Technical Committee Notes 1460
Industrial Engineering Notes 1461
IRE People 1462
Books:
3798. "Heaviside's Electric Circuit Theory," by H. J. Josephs ..... Reviewed by S. N. Van Voorhis 1465
3799. "Ionization Chambers and Counters," by H. D. Wilkinson ..... Reviewed by R. E. Lapp 1465
3800. "Atomic Physics," by Wolfgang Finkelnburg ..... Reviewed by J. B. Horner Kuper 1465
3801. "Primary Batteries," by George Wood Vinal ..... Reviewed by Donald McNicol 1465
3802. "The Principles of Television Reception," by A. W. Keen ..... Reviewed by Pierre Mertz 1466
3803. "Patent Practice and Management for Inventors and Executives," by Robert Calvert ..... Reviewed by R. A. Heising 1466
3804. "The Radio Manual," by George E. Sterling and Robert B. Monroe ..... Reviewed by John D. Reid 1466
3805. "High Speed Computing Devices," by Staff of Engineering Research Associates, Inc. ..... Reviewed by L. A. Zadeh 1467
3806. "Electromagnetic Theory," by Oliver Heaviside ..... Reviewed by Donald McNicol 1467
3807. "Wave Filters," by L. C. Jackson ..... Reviewed by C. W. Carnahan 1467
3808. "Circuits in Electrical Engineering," by Charles R. Vail ..... Reviewed by Knox McIlwain 1467
3809. Abstracts and References 1468
Annual Index ..... follows p. 1480
Section Meetings 38A
Student Branch Meetings 44A
Membership 49A
Positions Open 50A
Positions Wanted 54A
News—New Products 68A
Advertising Index 95A

Copyright, 1950, by The Institute of Radio Engineers, Inc.

EDITORIAL DEPARTMENT

Alfred N. Goldsmith
Editor

E. K. Gannett
Technical Editor

Mary L. Diamond
Assistant Editor

●

ADVERTISING DEPARTMENT

William C. Copp
Advertising Manager

Lillian Petranek
Assistant Advertising Manager

●

BOARD OF EDITORS

Alfred N. Goldsmith
Chairman

PAPERS REVIEW COMMITTEE

George F. Metcalf
Chairman

ADMINISTRATIVE COMMITTEE OF THE BOARD OF EDITORS

Alfred N. Goldsmith
Chairman

Responsibility for the contents of papers published in the PROCEEDINGS OF THE I.R.E. rests upon the authors. Statements made in papers are not binding on the Institute or its members.

MEMBER AUDIT BUREAU OF CIRCULATIONS

W. R. G. Baker

DIRECTOR, 1950

W. R. G. Baker, vice-president of General Electric Co., Electronics Park, Syracuse, N. Y., and a pioneer in the development of radio and television, was born at Lockport, N. Y. on November 30, 1892. A graduate of Union College with three degrees, Dr. Baker joined General Electric's Research Laboratory in 1917.

His first work on radio included the development and testing of radio apparatus for aircraft, submarines, captive balloons, torpedo boats, destroyers, and battleships. Dr. Baker was later made designing engineer.

In 1924 this responsibility was enlarged to include the design of all radio products, and in 1926, he was given complete charge of development, design, and production. He supervised the design of pioneer broadcasting stations WGY in Schenectady, KOA in Denver, and KGO in Oakland and the Schenectady radio developmental laboratory. The latter aided in maintaining communications with both Byrd Antarctic expeditions.

On the formation of the RCA-Victor Corporation in 1929, Dr. Baker went to Camden, N. J., to head the radio engineering activities of the new organization and was in charge of production and later vice-president of engineering and manufacturing.

In 1935 General Electric transferred its radio receiver activities to Bridgeport, Conn., and Dr. Baker resumed his connections with the Company. He was named managing engineer in 1936, a post he held until May, 1939, when he was promoted to the position of manager of the Company's radio and television department.

In October, 1941, Dr. Baker was elected a vice-president. His department was subsequently redesignated the Electronics Department, now one of the nine GE operating departments, and producer of radio, radar, television and similar equipment in the rapidly expanding electronics industry.

Under Dr. Baker's direction as Chairman of the National Television System Committee the standards for monochrome telecasting were developed, recommended, and adopted by the FCC. As Director of Engineering for the Radio-Television Manufacturers Association, he is actively engaged in co-ordinating the work of the industry on color television.

Under his supervision as chairman of the Radio Technical Planning Board, recommendations for frequency allocations of all broadcasting services were formulated.

Dr. Baker became a member of the Institute in 1919 and a Fellow in 1928. He was President in 1947 and a Director in 1940 and 1946–1950. Dr. Baker was Standards Co-ordinator during 1948 to 1950 and has served on numerous IRE committees.

The inventor of the modern electron tube, and of many other contributions to radio during the last half century, here describes the upward course of radio and offers counsel, based on experience, to his fellow workers of today and to the government officials entrusted with present administrative responsibilities.

The eminent writer of the following guest editorial needs, and can have, no better introduction than to state that he is LEE DE FOREST.—*The Editor.*

A Half Century

LEE DE FOREST

To those of our membership whose professional, or amateur, radio activities span the completed half century, the glance backward from today's eminence of achievement must surely be accompanied by sentiments of wonder and admiration, not unmingled with some nostalgia.

From the crude experiments of Oliver Lodge and Marconi in wireless transmission over the first few miles, when even a wavemeter was unknown, to the spanning of the Atlantic, first with Morse signals, then with the human voice from Arlington to Paris and Honolulu, and on down the years to today's universal network of radio communication of every type and description, shrinking our globe to a mere basketball, the technical progress therein involved defies total comprehension.

With this crowded accomplishment, no organized mental achievement, through the age-long history of the evolving human brain, can successfully compare.

In 1900 our total applicable technical library comprised chiefly the works of Maxwell, Hertz, Tesla, J. J. Thompson, Poincare, and Lodge. The single journals containing an occasional article helpful to the then *Wireless Engineer* were *Wiedemann's Annalen* and the *Philosophical Magazine* of London.

Other than the lone experimenters themselves, few indeed glimpsed at first any commercial future for "Wireless." Even the Army and the Navy saw but small usefulness in our manful efforts, employing alternating current transformers, self-restoring detectors and headphones, to excel the European pioneers with their still more primitive spark-coils, coherers, and tape recorders. Technical progress lagged shamelessly, tightly bound as we then were by the strait limitations of the open spark and arc transmitters. The quenched spark-gap of Max Wien and the electrolytic and crystal detectors were almost the sole instances of progress until entrance upon the scene of the three-element tube with plate supply, first as a far better detector, then as the long-awaited amplifier, poetically foretold forty years before by Professor's Hughes and Stokes—an "hour for which the years (and telephone engineers) did sigh."

As though in apt commemoration of the discovery of that promethean device, the Archimedian electronic lever, destined with feedback to move the world forward, our Institute of Radio Engineers was shortly thereafter established.

Its infant-sized PROCEEDINGS began forthwith to compete with Zenneck's *Jahrbuch der Drahtlos Telegraphie*, and was eagerly welcomed by those to whom German and Greek were essentially synonomous.

The demands and exigencies of World War I forced the swift development of the first watt oscillators into multi-kilowatt types which, with the power-modulation methods of Heising, thereafter made possible huge sponsored earnings by a theretofore virgin-pure radio broadcasting art—a sort of etheric prostitution new to mankind. So broadcasting for hire, like a surging epidemic, spread over the land. What untold tonnages of soap and so-forth were sold therewith; what hosts of otherwise undiscovered "talent" ranged and raged before our inoffensive microphones; what profound changes in our home life, in political destinies were thus unfolded! And what manifold new industries, whose swollen earnings have already totaled more than fifty billions, affording a million new jobs, have we seen founded upon, or grown great from, the electron tube!

Ensued then the regenerative and superhetrodyne receivers, entangled for years in historic patent litigation, even unto the Supreme Court, whereon the patent-lawyer fraternity fattened enormously. Simultaneously during the tumultous 'twenties the amplifying branch of the fast spreading electronic tree blossomed beautifully into sound-on-film, perfected music recording-reproduction, and the oscilloscopic parent of television-realizations of the ancient dreams of Edison and of von Rosing.

Progress during the third decade of our half century may be generally classified as intensified investigation of atmospheric phenomena affecting transmission, the introduction of the electron to industry, rapid development of frequency modulation by Armstrong, and the beginnings of cathode-ray television made possible by the brilliant genius of Zworykin and Farnsworth. Our accumulated store of information and the practical applications thereof added up to immense basic values, forming a firm foundation for what the fighting 'forties were to require.

There the demoniacal demands of World War II, blacking out all cost figures, forced a dozen premature births, such as radar, sonar, the proximity fuze, remote-controlled missles, and the electronic navigational aids that made possible today's congested aviation traffic.

Thus the present status of radio and electronics owes immeasurable debt to the two holocausts that have blackened the fair pages of the history of our first half-century.

Today's astounding public acceptance of television serves as a needed peacetime stimulation to yet swifter, more enobling efforts. Happily there are indications that in (long overdue) time the cultural values beyond all estimation, innate in radio and television, will be realized by those to whom we engineers have had to entrust the commercial applications of the miracles so hopefully created; that eventually the advertiser's profit motive will cease to be the prime factor in the instrumentalities we have been busily introducing into the home-life of America. Assuming that Russia values her peaceful place in the sun, color video, now only nascent, will be our next great contribution to the richness of that home life.

But what in addition to this awaits our world during the ensuing half-century? What further multiple and benign activities await the electron, as undreamed of now as were those of today to the embryonic radio profession of fifty years ago?

These the fortunate chronicler of A.D. 2000 alone can tell.

As we survey the history of modern technological advancement the world over, we find nothing comparable with the past half-century's achievements of American industry, scientifically directed; and nothing in all that vast progress surpassing that of our own radio-electronic structure. Today while our national economy, so often tormented by ill-conceived political restrictions and exactions, presents a rapidly darkening picture, the brilliant record of our special industry and science stands out as a challenging example of the basic virtues of the principle of free enterprise. Let us all therefore highly resolve to keep that proven principle unshackled by the socialistic sophistries which now seek, leech-like, to suck the life blood from our American capitalistic system.

That the record of the next half-century be no less glorious than that of the epoch now ending.

Periodical Literature for Electronic Engineers*

R. C. COILE†

Summary—**Periodical literature for electronic and communications engineers has been examined. Suggested lists of periodicals are presented, ranked by relative usefulness for keeping up with current progress and for finding previously published information. Problems of publishing, abstracting, and searching electronic literature are discussed.**

Introduction

ELECTRONIC engineers read periodical literature basically for two reasons; first, to keep abreast of current progress, and second, to find previously published information which may help on the particular project on which they are working. In the first instance, one of the problems facing an individual engineer and an academic or industrial library, is the determination of which technical periodicals and/or abstract journals should be read. In the second case, when previously published papers pertinent to a particular project are being searched for, the problems are to determine in which technical periodicals and/or abstract journals to search, as well as in what year to search, and further—how to search.

This paper examines some of the problems of periodical literature for electronic and communications engineers from the reader's point of view. A suggested list of periodicals ranked by relative usefulness is given for browsing and keeping up-to-date activities. Another list of periodicals whose papers have demonstrated more than ephemeral value is given. The time scale and age of published papers pertinent to a particular project have been studied from a probability basis.

Some of the problems of literature search and abstracting are discussed. Work on classification, storing, and handling information for the convenience of the reader is urgently required to cope with the growth of the electronic industry. The size of The Institute of Radio Engineers has been roughly estimated to be 80,000 in 1960 and the PROCEEDINGS OF THE I.R.E. should then be publishing about 800 papers per year.

Periodical Literature for Current Reading

One approach to determining which periodicals are currently publishing papers of interest to electronic engineers would be to examine a large number of current journals for a given period and determine how many pertinent papers on electronic subjects are being published and in which journals. Or instead of examining the journals directly, one might make a statistical study of an abstract journal such as *Science Abstracts* (Section B—*Electrical Engineering Abstracts*), or of the abstracts published in the *Wireless Engineer* and the PROCEEDINGS OF THE I.R.E. The abstract journals exercise a certain amount of selection in choosing which papers their editors consider worthy of abstracting.

A much greater degree of selection is employed by the IRE Annual Review Committee which prepares an annual Report listing the most significant papers published each year. An analysis has, therefore, been made of the recent Report[1] on "Radio Progress during 1949." This IRE committee of 29 members prepared a Report which contained 810 references to 134 periodicals. The report was divided into 22 subject fields with specialists in each field citing the most important papers published in that field in 1949. In passing, one might note that there was no subject field on "measurements"[2] and that only one reference was listed under "industrial electronics."

The periodicals are listed in relative rank in Appendix A, which shows the number of times the periodical was cited. Fig. 1 illustrates some of these data graphically. Fifty per cent of the references were made to 9 periodicals and 75 per cent were made to 24 periodicals. The last 25 per cent of the references required 110 additional periodicals.

The relative ranking of periodicals given in Appendix A depends, of course, on the subject fields considered. A different selection of subject fields will give a different ranking of journals. Furthermore, it is obvious that the more one restricts one's fields of interest, the fewer journals are pertinent. For example, if one is interested in keeping abreast of progress only in radio-frequency circuits, it is not necessary to read the *Journal of the Acoustical Society*, or the like. However, keeping posted on progress in a single field such as radio propagation requires reading journals in radio, electrical engineering, physics, applied physics, geophysics, and meteorology.

Appendix A, therefore, is suggested as a tentative guide for reading for engineers whose interests lie in the 22 subject fields considered by the IRE Annual Review Committee.

Periodical Literature Used by Electronic and Communications Engineers

The periodical literature actually used by electronic engineers may be determined by studying the footnote references in the technical papers published in the PROCEEDINGS OF THE I.R.E. Presumably these references were of some value to the engineer publishing an account of his own work. A study has been made of these references to determine their sources and ages. Appendix B shows the results of a study[3] made of the 1934 issues of the PROCEEDINGS OF THE I.R.E. The 42 periodicals mentioned in footnote references have been arranged in order of relative rank, with the journals referred to the most times ranked highest.

* Decimal classification: R053. Original manuscript received by the Institute, June 12, 1950; revised manuscript received, July 26, 1950.

† Operations Evaluation Group, Division of Industrial Cooperation, Massachusetts Institute of Technology, Cambridge, Mass.

[1] "Radio Progress During 1949," PROC. I.R.E., vol. 38, pp. 358–390; April, 1950.

[2] An IRE committee on Measurements and Instrumentation was formed during the latter part of 1949 and future Radio Progress Reports will therefore cover the field of measurements.

[3] Charles F. Dalziel, "Journals for electrical engineers," *Elec. Eng.*, vol. 57, pp. 110–113; March, 1938.

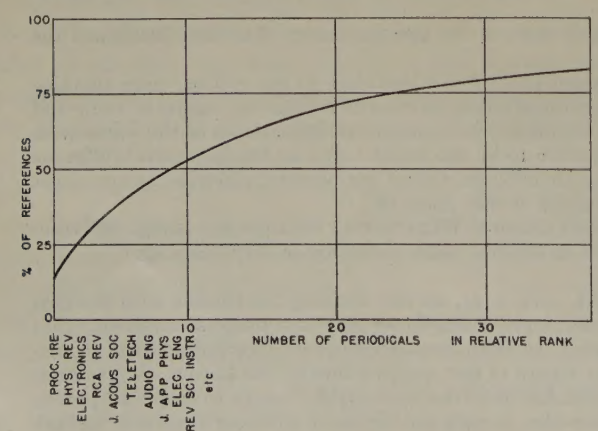


Fig. 1—Sources of reference in IRE Annual Review Report.

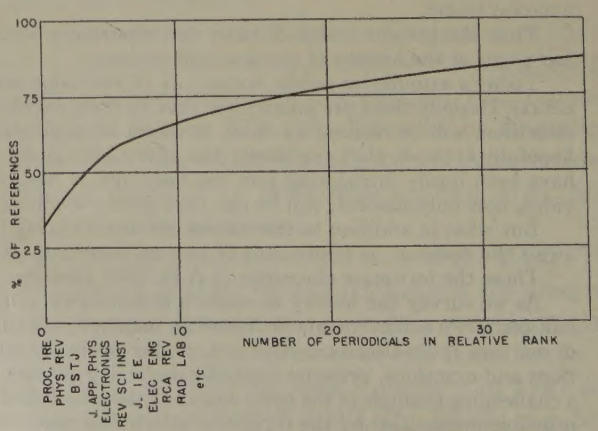


Fig. 2—Sources of references in 1949 PROC. I.R.E.

A study of the 1949 issues of the PROCEEDINGS OF THE I.R.E. is given in Appendix C. One hundred and fifteen periodicals were listed in references. To make this 1949 study comparable with the data for 1934 which excluded periodicals which were not mentioned also by one or more of a selected group of key journals, 73 of these 115 periodicals were determined to be also listed by one or more of the following: *Electrical Engineering, Journal of the Institution of Electrical Engineers, General Electric Review, Electronics,* and *Bell System Technical Journal.* Consequently, 73 periodicals were mentioned in 1949, as compared to 42 in 1934, an increase factor of 1.7. It is interesting to note the gains in relative rank of the *Physical Review, Bell System Technical Journal, Journal of Applied Physics, Electronics, Review of Scientific Instruments,* and *RCA Review.*

Fig. 2 shows graphically the sources of the 1949 IRE references. Fifty per cent of the references came from the first four journals and 75 per cent of the references came from the first 17 periodicals. Then 98 more periodicals accounted for the last 25 per cent of the references.

A study was made of the time interval between the publication year of a paper and its citation as a reference in the 1949 PROCEEDINGS OF THE I.R.E. Fig. 3 shows that 18 per cent of the references were two years old, 16 per cent were one year old, 13 per cent were three years old with decreasing frequency of occurrence for older references. Fig. 4 shows that 50 per cent of the references were less than three years old. Twenty-five per cent of the references were more than nine years old.

These surveys of the 1934 and 1949 issues of the PROCEEDINGS OF THE I.R.E. give an indication of the past use of published literature by engineers in past research programs. The distribution of the sources of the references and the ages of the references depended on the particular research programs reported in the papers. Academic research, for example, may result in a scholarly published paper with more historical footnote references than a paper by an engineer in industry reporting on a current development. It is felt, however, that the listing of periodicals in Appendix C gives an index of usefulness of journals covering the fields of interest to The Institute of Radio Engineers.

LITERATURE SEARCH

The information on sources and ages of references presented in the survey of periodical literature discussed above enables one to start on an "associative trail" type[4] of literature search. Examination of the top ranking five or six periodicals for three or four years back has a fair probability of uncovering papers pertinent to the subject being searched for. Footnote references in these papers furnish leads for further searching. In certain fields, a specialized periodical, e.g., *Journal of the Acoustical Society,* would be the logical place to start a search.

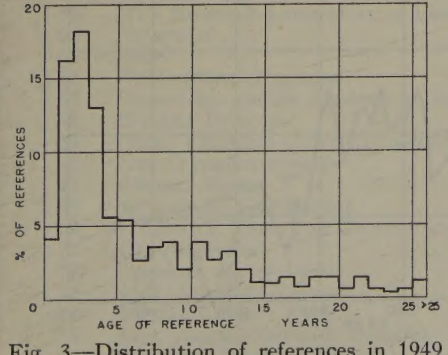


Fig. 3—Distribution of references in 1949 PROC. I.R.E. by age groups.

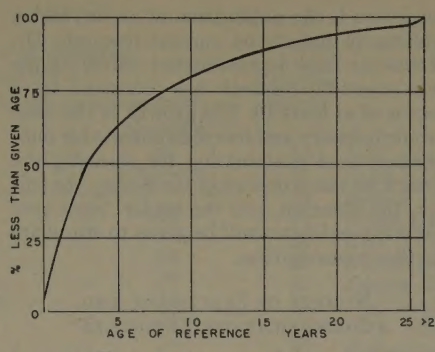


Fig. 4—Age of references.

Abstract journals and abstracting and referencing publications and organizations facilitate an all-out organized search. Some of the abstract and reference publications useful to electronic engineers are the following:

Radio Research Board Abstracts and References (published in the *Wireless Engineer* and reprinted in the PROCEEDINGS OF THE I.R.E.)
Science Abstracts—Section B (*Electrical Engineering* Abstracts)
Mathematical Reviews
References to Contemporary Papers on Acoustics (published in the *Journal of the Acoustical Society of America.*)
Wireless Patents (published in the *Wireless Engineer*)
Review of Acoustical Patents (published in the *Journal of the Acoustical Society of America*)
Engineering Index
Industrial Arts Index
Bibliography of *Scientific and Industrial Reports*
Annales des Telecommunications
Electronic Engineering Master Index
Electronic Engineering Patent Index

The general situation is confusing but it is generally agreed that, despite the large number of different abstracting agencies, many worthwhile papers are being overlooked while others are duplicated in many of the abstract journals.

Probably the most useful for electronic engineers of the above abstracts are those published in the *Wireless Engineer* and PROCEEDINGS OF THE I.R.E. About 80,000 abstracts prepared by the Radio Research Board in England have been published in the *Wireless Engineer* in the past twenty years. The approximate number of these abstracts published each year is given in Fig. 5. Over 4,000 abstracts were published each year for the eight years prior to World War II, with approximately 150 journals scanned.

[4] Vannevar Bush, "As we may think," *Atlantic,* pp. 101–108; July, 1945.

However, the disturbing effect of the breakdown of this abstracting service is indicated by the negative slope of the last four postwar years. In 1948 when 195 journals were scanned, only 3,575 abstracts were published. To have fewer abstracts for a year such as 1948, when thousands more papers were being published than during the war, does not lead to any confidence that a high percentage of pertinent published papers are being abstracted.

A further index of the abstracting activity is given in Fig. 6, where the number of abstracts per year per member of the IRE is shown. The negative slope as well as the small magnitude of this ratio is not encouraging.

When one wishes to use the 80,000 abstracts, one must still face the problem of searching in an annual index or in the 12 issues of the *Wireless Engineer* a year for as many of the past 20 years as desired (a maximum of 240 separate batches of 300 or so references). Some individuals and organizations have the abstracts arranged in card files. This poses the problem of a classification system. The *Wireless Engineer* abstracts had no classification numbers until four years ago when they began to be classified according to the Universal Decimal Classification System. *Electrical Engineering* Abstracts, similarly, had no classification numbers until eight years ago.

At the moment, the systems and aids available for literature search are very crude. It should be possible to mechanize part of the searching with modern electronic techniques. The Departments of Commerce and Agriculture and the Atomic Energy

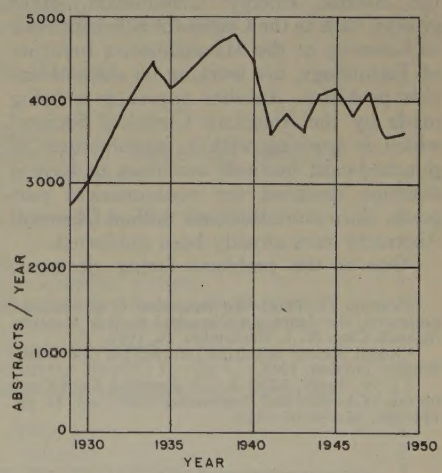


Fig. 5—Abstracts per year in *Wireless Engineer;* now also in PROC. I.R.E.

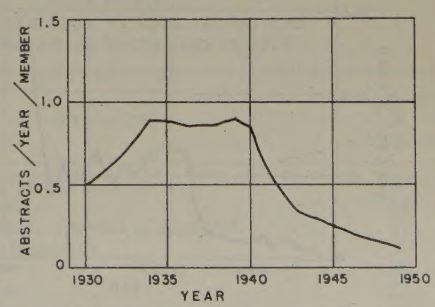


Fig. 6—Abstracts per year per IRE member.

Commission are now experimenting with and developing improved abstract selectors based on the Bush "Rapid Selector" library machine developed at the Massachusetts Institute of Technology in 1938–1940 by John Howard, Laurence Steinhardt, John Coombs, Claude Shannon, and the author.

Documentation

In the past, the problems of documentation have chiefly been the concern of the producers and not the consumers. Publishers and editors have decided publication policy primarily to solve their own problems. Rejecting and/or overcondensing a larger percentage of manuscripts and increasing the delay time between submission of a manuscript and its publication may temporarily solve some of an editor's problems of higher printing costs and increasing volume but are hardly the same solutions a reader would agree with. One alternative[5] under investigation by a professional society suggests that a journal composed solely of brief author abstracts be published at a low subscription rate with inexpensive microfilm copies of any complete paper supplied as desired to a reader.

Libraries are organized principally for the convenience of the librarian and not the reader. The classification systems are organized along medieval lines for the manual practices employed. However, it is encouraging that some groups are worrying about the problems of classifying, storing, and handling information.[6] In addition to the previously mentioned experimentation with microfilm abstract machines by the Departments of Commerce and Agriculture and the Atomic Energy Commission, other groups, such as the Center for Scientific Aids to Learning at the Massachusetts Institute of Technology, are working on documentation problems. Another approach is being made by the American Chemical Society[7] which is working with a manufacturer of punched-card business machines to have a machine designed for nonnumerical purposes, since more than one million Chemical Abstracts have already been published.

One of the problems facing electronic engineers is the publication of an increasing volume of reports on current research. Dr. Vannevar Bush has estimated that since the war scientific research has increased by a factor of at least 10. The growth of the electronic industry and its requirements for publication need examination for planning the attack on the problems of the writer, the editor, the librarian, and the reader. Some preliminary estimates will be given to stimulate further investigation.

Number of Electronic and Communications Engineers

An index of the growth of electronic and communications industry may be obtained from consideration of the membership of The Institute of Radio Engineers. The IRE was formed in 1913 and has grown as illustrated in Fig. 7. It will be seen that the trend of increasing membership would indicate a possible 47,000 in 1955, and a possible 80,000 in 1960. This assumes that no new national engineering societies will be formed which would absorb large numbers of the new electronic engineers who may not be specialists in "radio," and that The Institute of Radio Engineers continues its broad interests in electronics.

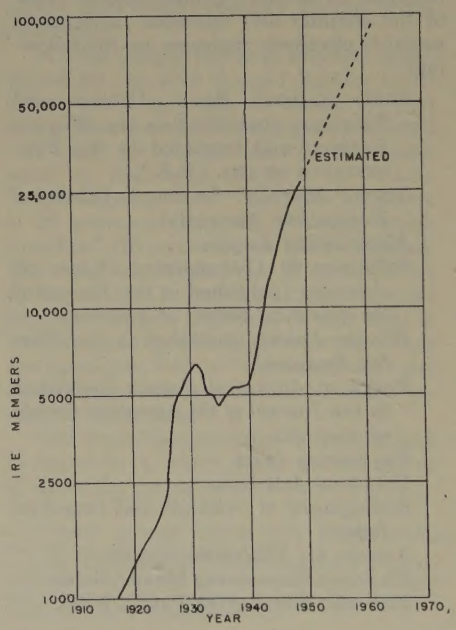


Fig. 7—IRE membership.

Proceedings of the I.R.E.

The Institute of Radio Engineers has had a publication from the time of its origin thirty-seven years ago. Fig. 8 shows the number of papers published per year in the Proceedings. Over 100 papers have been published each year since 1927, with the exceptions of one depression year and two World War II years. The number of "papers" includes book reviews which have been numerous in postwar years. For example, in 1948, of the total of 266 papers shown in Fig. 8, 173 were original technical papers and 93 were book reviews. The over-all figures have been used, as it is considered that both papers and book reviews need consideration in keeping abreast of the field.

During the war years when publication was curtailed, the Institute made plans and set aside special funds for large postwar publication of papers when the easing of security restrictions and paper restrictions permitted. Fig. 8 shows the marked increase in papers published in the postwar years. However, this increase has covered the deficit of the war years when many papers were not published which would have been published in normal times—if one is talking about a static condition. But the Institute is dynamic and has more than quadrupled its membership since 1940. The ratio of papers published per year per IRE member given in Fig. 9 shows the trend from 1914 to date and the projected trend which gives an estimate of 0.01 paper per year per member in 1960. If this trend is considered reasonable, the estimates of the growth of the IRE given previously would indicate that the size of the Proceedings in 1955 should be at least 550 papers, and 800 papers in 1960.

Acknowledgment

This paper is part of a preliminary study of the problems of documentation in electrical engineering literature being carried out in the Vail Library of the Massachusetts Institute of Technology. The author wishes to express his appreciation to Ruth McGlashan Lane, Vail Librarian, and Samuel H. Caldwell for helpful suggestions and encouragement.

The author further wishes to express his appreciation to Harold L. Hazen who suggested the investigation, and to Vernon D. Tate and James W. Perry for their interest and helpful discussions.

[5] Vernon D. Tate, "An Appraisal of Microfilm," presented, the American Chemical Society Meeting, Atlantic City, N. J., September 20, 1949.
[6] Royal Society Scientific Information Conference Report, London, 1948.
[7] J. W. Perry, "The A.C.S. Punched Card Committee," *Chemical and Engineering News*, vol. 27, pp. 754–756; March 14, 1949.

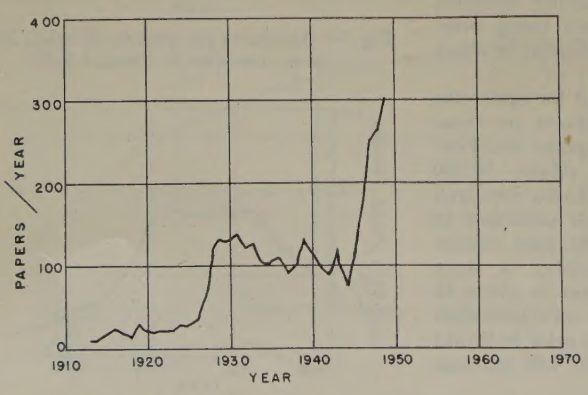


Fig. 8—Papers in Proc. I.R.E. per year.

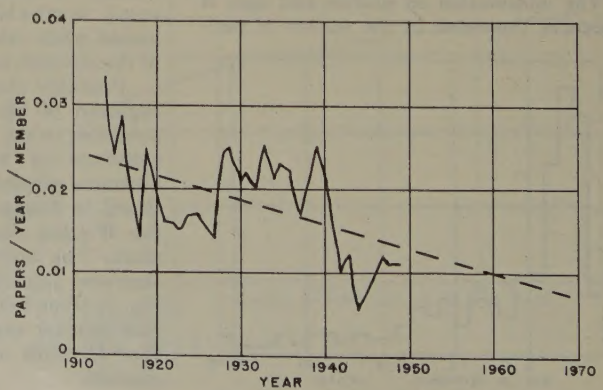


Fig. 9—IRE papers per year per member.

Appendix A

Periodicals for Current Reading in Electronic and Communications Engineering[1]

Relative Rank	Periodical	Number of Citations
1	Proceedings I.R.E.	118
2	*Physical Review*	57
3	*Electronics*	56
4	*RCA Review*	36
5	*Journal Acoustical Society of America*	32
6	*Tele-Tech*	31
7	*Audio Engineering*	28
8	*Journal Applied Physics*	27
9	*Electrical Engineering* (and *Transactions of AIEE*)	24
10	*Review of Scientific Instruments*	20
11	*Bell System Technical Journal*	19
12	*Journal Society Motion Picture Engineering*	18
13	*Digital Computer Newsletter*	17
14	*Wireless Engineer*	17
15	*Journal Institution of Electrical Engineers*	14
16	*Nature*	13
17	*Proceedings National Electronics Conference*	13
18	*L'Onde Electrique*	12
19	*Nucleonics*	12
20	*Communications*	11
21	*FM and Television*	11
22	*Compes Rendus Academy of Science (Paris)*	9
23	*Philips Technical Review*	9
24	*Bell Laboratories Record*	8
25	*Proceedings Physical Society*	7
26	*Technical Information Pilot*	7
27	Papers presented at AIEE Summer Meeting	5
28	Math Tables and Other Aids to Computation	5
29	*RMA Standards*	5
30	*A. E. U.*	4
31	Papers presented at AIEE Winter Meeting	4
32	*Electrical Communication*	4
33	*Journal Geophysical Research*	4
34	*Journal Scientific Instruments*	4
35	*Radio Television News*	4
36	*Railway Signaling and Communication*	4
37	*Telephone and Telegraph Age*	4
38	*The Engineer*	4
39	*Wireless World*	4
40	*American Standards Association*	3
41	*Ann. Radio Elec.*	3
42	*Electronic Engineering*	3
43	Papers presented at the IRE National Convention	3
44	*Observatory*	3
45	*Philips Research Reports*	3
46	*Proceedings Royal Society A*	3
47	*Western Union Tech. Rev.*	3
48	*Annual Telecommunications*	2
49	*Arch. Elek. Uebertragung*	2
50	*Astro. Journal*	2
51	*Bulletin Academy of Science (USSR)*	2
52	*Bulletin Assoc. Suisse Elec.*	2
53	*Engineering*	2
54	*Frequency*	2
55	*General Electric Review*	2
56	Papers presented at IRE Fall Meeting	2
57	*Journal Laboratory and Clinical Medicine*	2
58	*Journal Phys. Radium* (France)	2
59	MIT Research Laboratory of Electronics	2
60	*Naturwiss*	2
61	*Optik*	2
62	*Philosophical Magazine*	2
63	*Proceedings Indian Academy of Science*	2
64	*Sky and Telescope*	2
65	*Trans. Chalmers University of Technology*	2
66	*Acta Crystallographica*	1
67	*Advanc. Science*	1
68	*Agricultural Engineering*	1
69	AIEE-IRE Theory of Communication Lectures	1
70	*Alta Frequenza*	1
71	*American Mineralogist*	1
72	*Appl. Scientific Research*	1
73	*Ark. Mat. Astro. Fys.*	1
74	*Aust. Journal Scientific Research*	1
75	*Automat i Telemakh* (Russia)	1

Appendix A—(*continued*)

Relative Rank	Periodical	Number of Citations
76	*BBC Quarterly*	1
77	*British IRE*	1
78	*British Journal of Psych.*	1
79	Brush Dev. Co. *Quarterly Report*	1
80	*CRPL Report*	1
81	*Discussion of Faraday Soc.*	1
82	*Edison Electric Inst. Bulletin*	1
83	*Elec. Review* (London)	1
84	*Elek. Wiss. Tech.*	1
85	*Endeavour*	1
86	*Engineer*	1
87	*Fernmeldtech Z.*	1
88	*Federal Engineer*	1
89	*FIAT Review of German Science*	1
90	*Fortune*	1
91	*GEC Journal*	1
92	*Gen. Radio Tech. Pub.*	1
93	*Helv. Phys. Acta*	1
94	*HF (Brussels)*	1
95	*Indian Journal Phys.*	1
96	*Institute of Navigation*	1
97	*IBM Publication*	1
98	*Journal British Astro Association*	1
99	*Journal Chem. Phys.*	1
100	*Journal Electro Chem. Society*	1
101	*Journal Franklin Inst.*	1
102	*Journal Ind. Hygiene and Toxicology*	1
103	*Journal of Metals*	1
104	*Journal of Met.*	1
105	*Journal Optical Society of America*	1
106	*Journal Res. National Bureau Standards*	1
107	*Journal Royal Astro Society, Canada*	1
108	*Journal Tech. Phys. (USSR)*	1
109	*Kungl Tekn Hogsk Handl (Stockholm)*	1
110	*Marconi Review*	1
111	*Nuovo Cim*	1
112	*Physics Today*	1
113	*Proceedings IRE* (Australia)	1
114	*Quarterly Appl. Math.*	1
115	*Quarterly Journal Royal Met. Society*	1
116	*Radio Franç.*	1
117	*Radio Tech Dig* (France)	1
118	*Ry. Age*	1
119	*Radiotronics*	1
120	*Review Gen. Elec.*	1
121	Chalmers University of Technology Research Laboratory of Electronics	1
122	*Science Monthly*	1
123	*Tech. Bulletin National Bureau Standards*	1
124	*The Quill*	1
125	*Toute la Radio*	1
126	*Trans. American Geophys. Union.*	1
127	*Trans. American Society Mechanical Engineers*	1
128	*Trans. S. Afr. Inst. Electrical Engineering*	1
129	*University of Kentucky Report*	1
130	Wesleyan University Report to Sig C	1
131	Williams College Meeting American Phys. Society	1
132	*Zeits. Angew. (Phys.)*	1
133	*Zh. Tekh. Fiz.* (Russia)	1
134	*Zeit. Ver dtsch. Ing.* (VDI)	1

Appendix B

Periodicals Used by Electronic and Communications Engineers in 1934

Relative Rank	Periodical	Number of Citations
1	Proceedings of the I.R.E.	(180)
2	*Wireless Engineer*	37
3	*Bureau Standards Journal of Research*	31
4	*Philosophical Magazine*	30
5	*Nature*	30
6	*Physical Review*	23
7	*Bell System Technical Journal*	20
8	*Proceedings Physical Society*	20

APPENDIX B—(*continued*)

Relative Rank	Periodical	Number of Citations
9	*Proceedings Royal Society*	20
10	*Zeitschrift für Technische Physik*	19
11	*Annalen der Physik*	18
12	*Comptes Rendus*	17
13	*Elektrische Nachrichten Technik*	16
14	*Zeitschrift für Physik*	15
15	*Journal Acoustical Society*	15
16	*Journal Institution of Electrical Engineers*	14
17	*Hochfrequenztechnik und Elektroakustik*	10
18	*Archiv für Elektrotechnik*	10
19	*Electronics*	9
20	*Wireless World*	8
21	*Physikalische Zeitschrift*	7
22	*Telefunken-zeiturg*	7
23	*Journal Institution of Electrical Eng. of Japan*	6
24	*Radio Engineering*	6
25	*L'Onde electrique*	5
26	*Annales des Postes, Telegraphes et Telephones*	5
27	*Electrical Engineering*	4
28	*Helvitica Physica Acta*	3
29	*Alta Frequenza*	3
30	*Electrician*	3
31	*Physics*	3
32	*Electrotechnische Zeitschrift*	2
33	*Physica*	2
34	*Journal Franklin Institute*	2
35	*Journal Scientific Instruments*	2
36	*Journal Society Motion Picture Eng.*	2
37	*Astrophysical Journal*	1
38	*Electrical Communication*	1
39	*Trans. Optical Society*	1
40	*Review of Scientific Instruments*	1
41	*Electrical World*	1
42	*General Electric Review*	1

APPENDIX C

PERIODICALS USED BY ELECTRONIC AND COMMUNICATIONS ENGINEERS IN 1949

Relative Rank	Periodical	Number of Citations
1	PROCEEDINGS OF THE I.R.E.	(262)
2	*Physical Review*	56
3	*Bell System Technical Journal*	51
4	*Journal Applied Physics*	47
5	*Electronics*	34
6	*Review Scientific Instruments*	26
7	*Journal IEE*	22
8	*Electrical Engineering*	16
9	*RCA Review*	15
10	*Rad. Laboratory Reports*	13
11	*Cruft Laboratory Reports*	11
12	*Nature*	11
13	*Wireless Engineer*	11
14	*Electrical Communications*	9
15	*Philosophical Magazine*	9
16	*Proceedings Royal Society*	8
17	*Journal Franklin Institute*	7
18	*Communications*	6
19	*General Rad. Experimenter*	6
20	*Journal Acoustical Society of America*	6
21	*Journal Society Motion Picture Engineers*	6
22	*Proceedings Phys. Society*	6
23	*Proceedings Nat. Electronics Conference*	6
24	*Research Lab. of Electronics*	6
25	*Tele-Tech.*	6
26	*Zeit. für Phys.*	5
27	*Archiv. für Elek.*	5
28	*Bulletin American Meteorological Society*	5
29	*Helv. Phys. Acta*	5
30	*Ind. Eng. Chem.*	5
31	*Phys. Zeit.*	5
32	*Review Mod. Physics*	5
33	*University Texas E. E. Research Lab.*	5
34	*Journal Math. Phys.*	4
35	*Journal Optical Society of America*	4

APPENDIX C—(*continued*)

Relative Rank	Periodical	Number of Citations
36	*Physica*	4
37	*Annales der Phys.*	3
38	*Bell Laboratory Research*	3
39	*Elek. Nach. Tech.*	3
40	MDDC	3
41	*Proceedings American Philosophical Society*	3
42	*Science*	3
43	*American Journal Physics*	2
44	*Chalmers Tek.*	2
45	*Comptes Rendus*	2
46	*Doklady Academy Science Ukraine*	2
47	*Electrical Journal*	2
48	*Funk und Ton*	2
49	*Food Ind.*	2
50	*Hochfrequenza und Elektroak.*	2
51	*Journal General Physiology*	2
52	*Journal Research National Bureau Standards*	2
53	*Journal Scientific Instruments*	2
54	*Leiden Comm.*	2
55	*Nucleonics*	2
56	*Oak Ridge Nat. Lab.*	2
57	*Philips Research Reports*	2
58	*Physics*	2
59	*Proceedings Cam. Philosophical Society*	2
60	*Quarterly Applied Mathematics*	2
61	*Review Gen. Elec.*	2
62	*Zeit Phys.*	2
63	*Z. Naturf.*	2
64	*American Math. Society Bulletin*	1
65	*Annales de Telecommunications*	1
66	*Annales Radio-elec.*	1
67	*Anal. Chem.*	1
68	*American Journal Roentgenology and Rad. Therapy*	1
69	*Bell Tel. Quarterly*	1
70	*British Journal Radiology*	1
71	*Brooklyn Polytechnic Inst.*	1
72	*Bulletin Soc. Franç. Elec.*	1
73	*Bulletin Academy Royal Belgique*	1
74	*Bureau Standards Scientific Papers*	1
75	*Camp Evans Signal Lab. Report*	1
76	*Chemical and Engineering News*	1
77	*Chem. and Ind.*	1
78	*Das Electron*	1
79	*Elec. Ind.*	1
80	*Electronic Eng.*	1
81	*Stanford U. Electronics Research Lab.*	1
82	*AMC Electronics Research Lab.*	1
83	*Geophys. Publik.*	1
84	*Ind. Radiography*	1
85	*Journal Aero Science*	1
86	*Journal American Chemical Society*	1
87	*Journal Applied Mech.*	1
88	*Journal British Inst. Rad. Eng.*	1
89	*Journal Chem. Phys.*	1
90	*Journal Phys. and Colloid Chemistry*	1
91	*Journal Phys. Chem.*	1
92	*Journal Phys.* (URSS)	1
93	*Journal Phys. Radium*	1
94	*Journal Royal A, Society Cam.*	1
95	*L'Onde Elec.*	1
96	*Luftfohrforschung*	1
97	*Naturwissenschaften*	1
98	*Nova Acta Royal Society Science (Uppsala)*	1
99	*Phil. Tech. Review*	1
100	*Proceedings Nat. Academy Science*	1
101	*Product Eng.*	1
102	*Radio*	1
103	*Radio Research Board*	1
104	*Science Monthly*	1
105	*Stanford U. Micro-Wave Lab.*	1
106	*Tech. Mitt. Jg.*	1
107	*Terr. Mag. Atmo. Elec.*	1
108	*The Oscillator*	1
109	*TRE*	1
110	*U. S. AEC Report*	1
111	*Wissenschaften Aero, Siemens*	1
112	*Westinghouse Eng.*	1
113	*Wireless World*	1
114	*Zeit. Tech. Phys.*	1
115	*VDI Zeitschrift*	1

Practical Design for Effective Production and High Quality*

JOSEPH MANUELE†

The following paper has been made available for publication through the good offices of the IRE Professional Group on Quality Control, and has received the approval of that Group.

Summary—**Every newly developed appliance must pass through three stages before finally reaching the home; namely, the laboratory model stage, the engineering model stage, and the mass production stage. The engineering model stage is really the "pilot plant" stage of production where the laboratory model is proved and the manufacturing "bugs" are worked out before placing the article in mass production.**

The engineering model stage of manufacture is controlled most effectively by the verification committee whose function it is to prove that component parts as well as the article itself can be, or cannot be, manufactured with the existing equipment and personnel. The verification committee proves that the engineering department has really come up with a good idea which is practical and which can be manufactured economically and in quantities. The verification committee also points out weaknesses in design.

The verification committee is guided in its analyses and recommendations by the principles governing practical design for effective production and high quality, which are: (1) simplicity of design, (2) minimum number of component parts, (3) clearly defined and measurable quality standards, and (4) absolute interchangeability of parts.

HISTORY RECORDS that in the late 1790's Eli Whitney was granted a contract from the United States government to make some muskets. In those days muskets were made by trained artisans, and each musket was as good as the skill of the individual worker could make it. Presumably if a gun were damaged in battle action, a soldier could not take parts from another damaged gun to repair his own. There was no recognition of the principle of "interchangeability of parts" in those days. Neither was the importance of designing for effective production recognized, and product quality reflected a combination of the worker's skill and pride in his job.

But Eli Whitney was a shrewd industrialist. He recognized the importance of design for effective production, and of the value of the principle of interchangeability of parts. He could do nothing about the design of the muskets, since this was already fixed, but before he started production, he made a set of gages for the various parts. Then he made the parts to the gages. Hence, every part could be assembled into its proper place on any musket, and the musket would function perfectly. History does not record whether there was a renegotiation on the contract, but we suspect that Mr. Whitney made a satisfactory profit on the transaction because of the cost reduction effected by his simplification in manufacturing method.

This incident really marks the beginning of modern "straight line" manufacturing techniques. These mass production methods are responsible for having made America great, and for having provided Americans with more comforts and more leisure than some of us are able to use wisely.

However, the art and science of product design to facilitate mass production has not always kept pace with progress in manufacturing methods. When contemplating a new design, how often have we heard the remark, "But can it be mass produced?" Because of the tremendously large and profitable American market, competition to reach that market is intensely keen. Hence, products intended for the American home must be mass-produced, if they are to be profitable.

Every newly developed home appliance usually goes through three stages before finally finding its place in the American home as a necessity, or even a luxury, of everyday living: (1) laboratory model stage, (2) engineering model stage, and (3) mass-production stage.

After the product has germinated in the mind of the inventor, the first stage it must pass through is the laboratory model stage. Here some of the theoretical principles of its operation are proved, modified or discarded. The main interest here is "Will it work?" Has the inventor really produced something of practical value, or has he just "laid an egg"? This laboratory model stage is very important because every year the ingenious mind of man creates many new products, some of which are just plain duds, and some of which can be termed only as scientific curiosities. Obviously industrial capital cannot be risked on duds, or scientific curiosities, manufactured by the million. Hence such new creations must be proved in the laboratory.

After the product has passed successfully through the laboratory model stage and it has been definitely proved that a product of some practical value has been developed, it is put through the engineering model stage. Here, the aim is to adapt the new product for profitable mass production. Changes in engineering design are made, if required to facilitate production in quantities. The various "bugs" are taken out of it, and the product is streamlined for "tooling." It is at this

* Decimal classification: R004×R720. Original manuscript received by the Institute, May 11, 1950. Presented, 1950 National IRE Convention, March 7, 1950, New York, N. Y.

† Westinghouse Electric Corporation, Pittsburgh, Pa.

stage that tool-made samples are produced to prove tools, production methods, and the product itself. Costs of production also are estimated at this point, and a sufficient number of units are manufactured and made available to the quality control department for a thorough "quality analysis" of the product.

Because of difficulties in meeting quality standards, or because of manufacturing problems which cannot be resolved, some products never get beyond this engineering model stage, and they are "put on the shelf," or "killed," at this time. Sometimes they are sent back to the engineering department with suggestions for redesign, and are later brought back through the engineering development stage a second time.

During this period of engineering development the *verification committee*, of the quality control department makes its quality analysis of "production method" produced samples, and gives its recommendations on whether the product: (1) comes up to proper quality standards, and (2) whether the design of component parts, and the product as a whole, lends itself to economical mass production with the available tools and personnel.

In order to make this quality analysis, a few units of the new product are manufactured, as nearly as possible, under production conditions, and these units are turned over to the quality control department for inspection and test in the regular way. No special inspection or test procedures are used at this point, and no special concessions are made in regard to product quality. The product is judged against the engineering quality standards which have been established, even though these standards may be tentative at this time.

Each part, component, and the completely assembled product, is inspected and tested, and a note is made of the *actual quality* and the *desired quality*. From this information a report is prepared, on regularly prepared forms, and submitted to the verification committee.

The function of the verification committee is twofold: to determine whether the product is of such quality that it will give the minimum amount of trouble in the field, from both the functional and aesthetic point of view; and whether the product and its various components can be mass-produced with the available manufacturing facilities and personnel.

The verification committee consists of an authorized representative from each of the following: (1) manager of quality control, (2) superintendent of manufacturing, (3) manager of engineering, (4) manager of sales, and (5) purchasing agent.

The product and its components are kept in the engineering development stage, and released for regular production only after the verification committee has given its approval. The verification committee may recommend design changes to facilitate mass production, and it may also recommend changes in manufacturing methods, or tools, if this appears desirable. The object is to take the "bugs" out of the product so that, when it is put in production, no major production difficulties will be encountered.

When a product gets into production it is subjected to the strictest kind of inspection and testing in order to evaluate its functional qualities, and unless it meets well-defined, and often rather narrow, quality standards, rejections may be rather high and costly. Furthermore, a product in the production stage must move rather smoothly along the processing line. It is desirable that it lend itself to manufacturing and assembly by relatively unskilled labor, since skilled labor is generally scarce and costly.

It is during this engineering development stage that the design of the product is really tested for effective production and high product quality. Practical design for effective mass production requires absolute interchangeability of parts. These parts must be interchanged without the necessity of "fitting at assembly," or "adjusting at test." It is true that this ideal is "approached" more frequently than it is "achieved." However, it is when this ideal of absolute interchangeability is achieved that profits are highest, and product quality is most satisfactory.

To achieve this ideal of absolute interchangeability it is necessary that component parts be made to clearly defined and measurable quality standards. These quality standards must provide for sufficient variability to permit economical manufacturing, and yet this variability must be within sufficiently narrow limits to allow the part to operate satisfactorily in the completed unit, without the need of fitting at assembly, or adjusting at test.

These adjustments at assembly mean higher manufacturing costs and somewhat less uniform, though in some cases, better quality. Adjustments made in this manner are subject to the skill of the tester, and no two testers work exactly alike; nor do they possess the same skill and judgment. Furthermore, since these testers generally require training for some period of time, their labor rates are higher. Therefore, the aim, when designing for effective mass production, should be to:

(1) Simplify the design of component parts and the product, so that all operations may be performed by relatively unskilled operators.

(2) Establish such quality standards for component parts as will make the achievement of interchangeability a practical reality.

(3) Reduce the number of component parts to a minimum. This will reduce the cost of component parts required, and the cost of the assembly operation.

(4) Make effective use of the verification committee to make a proper quality analysis of the product, to prove the design for effective production and satisfactory quality.

But assuming that all of these four steps have been taken and the new product has passed satisfactorily through the laboratory model stage and the engineering model stage, and it has been given the proper approval

for regular production by the verification committee, it does not necessarily follow that the production stage will be free of all difficulties, regarding either production, or quality. Production bottle-necks will be encountered, and it will be found difficult to maintain proper quality standards under the usual press for production. Pertinent and accurate information must be carried back to the design engineers so that designs can be altered to facilitate production in order to break production bottlenecks, or to improve quality, if it is felt that design changes will achieve these aims.

However, design changes during the production stage are costly; they interfere with production, and they require additional expenditures for tools. Therefore, these must be kept at a minimum. In many cases it has been found advantageous to "freeze" designs for a definite period. During this period, all desired changes are accumulated. Then at the end of the specified period, all accumulated changes are made in one major redesign of the product. Of course this procedure cannot be followed if difficulties are of such a nature as to interfere with production, or if quality is so poor as to result in excessive field trouble, or in a possible dropping off of customer acceptance of the product.

In order that correct and useable information might be had on the success of the product in passing through the production stage, it is necessary that adequate records be accumulated by the shop. The quality-control charts kept by the quality control department will generally be found satisfactory for this purpose. Every design engineer should review, critically, these quality-control charts, at least weekly. He should study these charts from two points of view: (1) Is the quality which he established for his product being properly maintained? and (2) If the shop is having trouble achieving a proper level of quality, can he redesign or modify the product to make this attainment easier?

The design engineer's responsibility for his product does not end when the product has been placed in production, although many engineers seem to think so. Design engineers can acquire a liberal engineering education from shop operatives who fabricate the product. "Simplicity of design" is a phrase which covers a vast engineering territory, but it is a goal more held in the breach than in the observance. The design engineer, therefore, will do well to spend some time "on the floor," at least several times each week, to note how well his brain child is thriving on the rough fare the shop personnel is able to feed it. High rejections and high manufacturing costs may not always be due to poor manufacturing methods.

In summing up, it can be said that the good design engineer who wishes to produce a practical product design for effective production and high quality, must keep uppermost in his mind: (1) simplicity of design, (2) minimum number of component parts, (3) clearly defined and measurable quality standards, and (4) absolute interchangeability of parts.

Graphical Analysis of Transistor Characteristics*

LLOYD P. HUNTER†

Summary—**Graphical constructions are given which will determine the circuit constants necessary for the design of voltage amplifiers, current amplifiers, and oscillators, from the dc characteristics of the transistors to be used.**

SEVERAL papers[1,2] have been published analyzing the characteristics of transistors from the point of view of equivalent circuits. These analyses are quite cumbersome to apply to the typical transistor since its characteristics change so much over its range of operation that no simple equivalent circuit can be set up to give its full behavior, and the constants of a simple equivalent circuit must be re-evaluated at each new operating point. If a graphical method is used, however the analysis will apply to all parts of the operating range of a given transistor and will lead to a visualization of the type of transistor characteristic that will do a given job. The purpose of this paper is to demonstrate such a graphical method.

Perhaps the most striking difference between a transistor and a conventional vacuum triode is that in the tube there is no reaction of the plate circuit upon the grid circuit, while in the transistor the emitter characteristics are greatly modified by the collector circuit. This means that the behavior of a transistor must be deduced from two sets of volt-ampere characteristics rather than one. The two sets of volt-ampere characteristics used here are those of the emitter and the collector, rather than two sets of some sort of mutual characteristics. These characteristics suffice to show the basic relations involved and are the two sets most easily and naturally measured.

* Decimal classification: R282.12. Original manuscript received by the Institute, March 20, 1950; revised manuscript received, August 22, 1950.

† Westinghouse Research Laboratories, East Pittsburgh, Pa.

[1] R. M. Ryder and R. J. Kircher, "Some circuit aspects of the transistor," *Bell Sys. Tech. Jour.*, vol. 28, p. 367; July, 1949.

[2] W. M. Webster, E. Eberhard, and L. E. Barton, "Some novel circuits for the three-terminal semiconductor amplifier," *RCA Rev.*, vol. 10, pp. 5–17; March, 1949.

In Fig. 1 are shown the volt-ampere characteristics for both the collector (output) and emitter (input) sides of a typical transistor, connected as shown. The circuit is that of a simple voltage amplifier. If a load line R_c is drawn in the collector (output characteristic) plane and is transferred point by point to the emitter (input characteristic) plane, the quiescent operating point will be the intersection of this line with the ordinate erected at $V_e = E_e$, the emitter bias supply voltage. The input impedance will then be given by the slope of this transferred load line at the operating point.

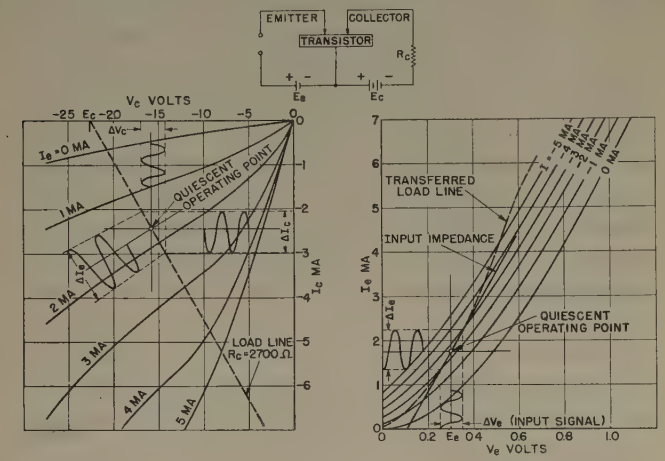


Fig. 1—Transistor of typical characteristics connected as a voltage amplifier. (a) Collector (output) characteristic. (b) Emitter (input) characteristic.

If the input signal ΔV_e is traced through the input diagram to give ΔI_e, and this value is transferred to the output diagram, it can be seen to result in a voltage swing ΔV_c along the load line in the collector characteristic. For the example shown, the voltage gain $\Delta V_c/\Delta V_e$ is seen to be about 30. This is typical for an average transistor. The distortion of this amplifier depends on the curvature of the transferred load line at the operating point. At the operating point chosen for the example there is considerable curvature and therefore distortion. To illustrate this, an operating point at 0.5 volt and 4 milliamps in the emitter plane would show practically no distortion, since the transferred load line has an inflection point in this neighborhood and is nearly linear over quite a range. The characteristics of nearly all transistors show an inflection point in the transferred load line so that there is some region of reasonable extent which may be picked for distortionless operation.

In the example shown, the input impedance is quite low (about 100 ohms) while the output impedance is moderate (2,700 ohms). Since ΔI_e nearly equals ΔI_c, this impedance ratio is seen to be primarily responsible for the voltage amplification. This means that one could not design a multistage voltage amplifier using transistors of such characteristics in direct cascade without some sort of transformer coupling which would bring the output impedance of one stage more nearly in line with the input impedance of the following stage. It is possible, however, to use a transistor of these characteristics as a current amplifier in such a way that a multistage amplifier may be designed having alternate stages of voltage and current amplification without having to resort to transformer coupling.

In order to use the transistor as a current amplifier of considerable gain, one must utilize feedback in one form or another. One direct method of doing this is to use the base lead of the transistor for the input, and the emitter resistance R_e as the output. Such a situation is shown in Fig. 2. As before, the first step in analyzing this circuit is to draw the load line R_c in the collector characteristic plane and transfer this load line point by point to the emitter characteristic plane. The quiescent operating point (operating point 1) is determined by the intersection of this transferred load line and the emitter load line R_e in the emitter plane. A signal voltage ΔV applied at the input terminals, and of such a polarity as to increase the emitter current, will effectively add to the emitter bias voltage E_e, and subtract from the collector supply voltage E_c. Since $|E_c| \gg |E_e|$ we will neglect the displacement of R_c and consider only the displacement of R_e, as shown in the emitter characteristic. This new load line determines a new operating point (operating point 2). If these two operating points are transferred back to the collector plane, a value of ΔI_c may be read.

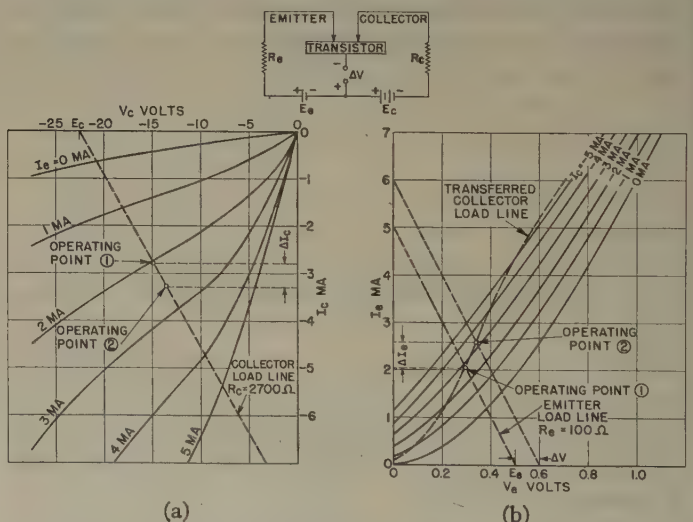


Fig. 2—Transistor of typical characteristics connected as a base-input amplifier. (a) Collector characteristic. (b) Emitter characteristic.

Since the current in the base lead is the algebraic sum of ΔI_c and ΔI_e, and ΔI_c is in general negative when ΔI_e is positive, it is easy to see that the input impedance may be either positive or negative, depending upon the sign of this algebraic sum. If the resistances R_e and R_c are so chosen that $|\Delta I_e| > |\Delta I_c|$ for the polarity of test voltage shown in the example, the input impedance is positive, and the current gain ξ is given by $\Delta I_e/\Delta I_e + \Delta I_c$. (The current through the emitter load resistance R_e is considered the output current.) The condition that $|\Delta I_e| > |\Delta I_c|$, mentioned above, is easily satisfied for any transistor, regardless of the magnitude of its short circuit current gain by simply making R_c large enough.

By reference to Fig. 3 we will derive a graphical construction for the determination of R_c to provide a desired current gain ξ in such a current amplifier working at an arbitrary operating point. Fig. 3 (a) shows a portion of a collector plane in which a load line R_c makes the angle θ with the current axis, and the perpendicular to the lines of constant emitter current through the operating point makes the angle β with the current axis. δl represents the portion of the load line covered with a given signal ΔV across the base terminals. The projection of this segment on the current axis gives the collector-current change δI_c, and its projection on the perpendicular to the lines of constant I_e gives the change in emitter current δI_e. Let ΔL_c be the length in this plane of one unit of collector current and ΔL_e be the length in this plane of one unit of emitter current as shown.

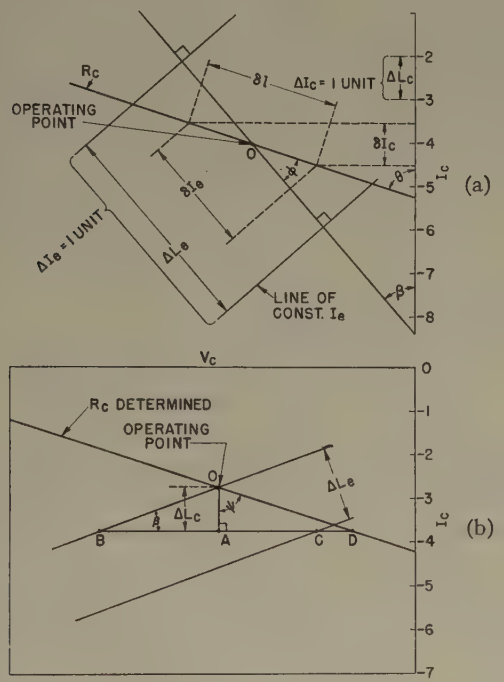


Fig. 3—Graphical construction for determining R_c in a current amplifier of arbitrary gain ξ for a given operating point. (a) Collector plane. (b) Collector plane construction.

From Fig. (3a) then:

$$\left.\begin{aligned} \delta I_e &= \frac{\delta l}{\Delta L_e}\cos\phi \\ \delta I_c &= \frac{-\delta l}{\Delta L_c}\cos\theta \end{aligned}\right\}; \tag{1}$$

and from the above definition of current gain ξ, we have

$$\xi(\delta I_e + \delta I_c) = \delta I_e; \tag{2}$$

substitution of (1) into (2) gives the relation

$$\xi\left(\frac{\delta l}{\Delta L_e}\cos\phi - \frac{\delta l}{\Delta L_c}\cos\theta\right) = \frac{\delta l}{\Delta L_e}\cos\phi. \tag{3}$$

From the geometry of the diagram, $\phi=\theta-\beta$, whence $\cos\phi=\cos(\theta-\beta)=\sin\theta\sin\beta+\cos\theta\cos\beta$. Substituting in (3) and multiplying by $\Delta L_e/\xi$ gives

$$\sin\theta\sin\beta+\cos\theta\cos\beta-(\Delta L_e/\Delta L_c)\cos\theta = (1/\xi)(\sin\theta\sin\beta+\cos\theta\cos\beta).$$

Dividing by $\cos\theta$ gives

$$(\tan\theta\sin\beta+\cos\beta)\left(1-\frac{1}{\xi}\right)=\frac{\Delta L_e}{\Delta L_c},$$

or

$$\tan\theta = \frac{\Delta L_e}{\Delta L_c}\,\frac{\xi}{\xi-1}\csc\beta - \cot\beta. \tag{4}$$

Thus $\tan\theta$, the slope of the desired load line, is given in terms of the required gain ξ and certain functions of the volt-ampere characteristics.

Equation (4) may be readily solved graphically by the procedure illustrated in Fig. 3(b). Draw a line OA of length ΔL_c parallel to the I_c axis through the operating point O. Draw BC through A parallel to the V_c axis. The angle OBA is now the angle β, and from the geometry of the diagram

$$\left.\begin{aligned} BA &= \Delta L_c\cot\beta \\ BC &= \Delta L_e\csc\beta \end{aligned}\right\}. \tag{5}$$

The line BC is extended to D making

$$BD = \frac{\xi}{\xi-1}BC. \tag{6}$$

The desired load line R_c is now drawn through O and D. From geometry and (5) and (6),

$$\Delta L_c\tan\psi = AD = BD - BA$$
$$= \Delta L_e\frac{\xi}{\xi-1}\csc\beta - \Delta L_c\cot\beta.$$

Dividing by ΔL_c and comparing to (4), we see that,

$$\tan\psi = \frac{\Delta L_e}{\Delta L_c}\,\frac{\xi}{\xi-1}\csc\beta - \cot\beta = \tan\theta, \tag{7}$$

proving that the desired load line R_c is indeed the line OD.

The input resistance R_i of such a current amplifier depends now on the resistance R_e in the emitter circuit. In order to determine R_e to give an arbitrary input impedance R_i, where

$$R_i = \frac{\Delta V}{\delta I_e + \delta I_c} = \frac{\xi\Delta V}{\delta I_e} \tag{8}$$

we will refer to Fig. 4. In Fig. 4(a) $\delta l'$ is the length of the segment of the transferred collector load line R_c which is swept out with the signal voltage ΔV. Its projection on the I_e axis is δI_e. The length $\Delta L_e'$ is equal to one unit of I_e in this plane and the length ΔL_v is equal to one unit of V_e. By inspection

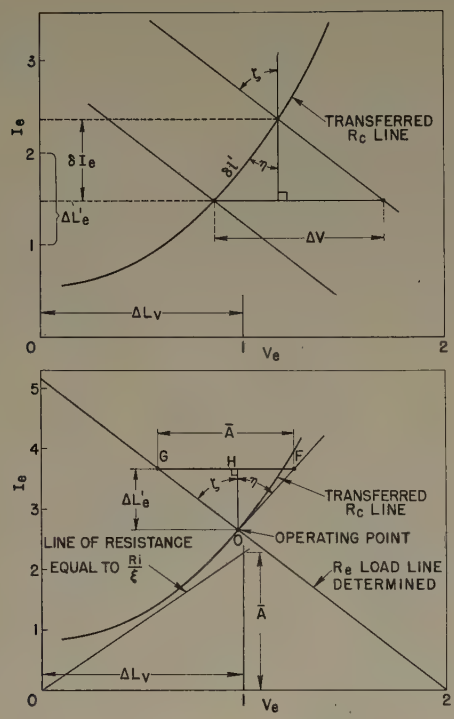


Fig. 4—Graphical construction for determining R_e in a current amplifier of arbitrary gain ξ and input impedance R_i for a given operating point. (a) Emitter plane. (b) Emitter plane construction.

$$\left.\begin{aligned} \delta I_e &= \frac{\delta l'}{\Delta L_e'} \cos \eta \\ \Delta V &= \frac{\delta l'}{\Delta L_v} \sin \eta + \left(\frac{\delta l'}{\Delta L_v} \cos \eta \right) \tan \zeta \end{aligned}\right\} \tag{9}$$

where η is the angle between $\delta l'$ and a parallel to the I_e axis and ζ is the angle the load line R_e makes with this axis. By substituting (9) into (8) we obtain the relations:

$$\left.\begin{aligned} R_i &= \xi \left(\frac{\Delta L_e'}{\Delta L_v} \{ \tan \eta + \tan \zeta \} \right) \\ \tan \zeta &= \frac{R_i}{\xi} \frac{\Delta L_v}{\Delta L_e'} - \tan \eta. \end{aligned}\right\} \tag{10}$$

In (10) the slope of the desired emitter load line ($\tan \zeta$) is given in terms of the desired current gain ξ, and the desired base input resistance R_i. The other quantities in the equation may be determined from the emitter volt-ampere characteristics.

With the aid of Fig. 4(b) we may readily solve (10) graphically. From the operating point O, an ordinate of length $\Delta L_e'$ is erected. Through its upper end H, a horizontal line is drawn which intersects, in the point F, the tangent to the transferred R_c line at the operating point. From the geometry we see that

$$HF = \Delta L_e' \tan \eta. \tag{11}$$

Now a line of resistance R_i/ξ is drawn through the origin and its ordinate $\overline{A}$ at $V_e = 1$ is determined. By geometry,

$$\overline{A} = \frac{R_i}{\xi} \Delta L_v. \tag{12}$$

The length $\overline{A}$, laid off along FH, determines the point G. Finally, we see by geometry that,

$$GH = \Delta L_e' \tan \zeta = \overline{A} - HF. \tag{13}$$

If (11) and (12) are substituted into (13) and the whole equation is divided by $\Delta L_e'$, we obtain (10), proving that the line GO determines the desired emitter load line R_e.

We have now completed the design of our current amplifier with a given gain and input impedance, using only graphical construction in the dc emitter and collector characteristic planes. In design work this procedure may take the place of the equivalent circuit analysis cited in the references, and seems to be a much simpler and faster method to use.

The base-input circuit of Fig. 2 has been described as a current amplifier. The same circuit can be used as a high-input-impedance voltage amplifier if the collector resistance R_c is used as the output resistance. If the input signal ΔV is traced through the emitter diagram to give ΔI_e, and this value is transferred to the collector diagram it is seen to result in a voltage swing along the collector load line of about 1.5 volts. In this example then the voltage gain would be about 15.

In discussing the voltage amplifier of Fig. 1, it was pointed out that a multistage amplifier could not be made using emitter input circuits in direct cascade without some means of impedance matching between the stages, such as transformers. From the above analysis of the base-input current amplifier, it is clear that in most cases it should be possible to design the input impedance of such an amplifier to match the output impedance of the emitter-input voltage amplifier so that a multistage amplifier could be built by using alternate stages of voltage and current amplification without having to insert impedance-matching components. The base-input circuit when used as a high-input-impedance voltage amplifier may be directly cascaded. In such a case the input resistance R_i (10) may be adjusted to equal the output resistance R_c by adjusting the emitter resistance R_e in each stage, as described above.

From (8) we see that the input impedance of a base-input circuit becomes infinite if the current gain ξ becomes infinite. This is equivalent to saying that $\delta I_e = \delta I_c$. Under these conditions the construction of Fig. 3(b) reduces to drawing the load line through OC, since $(\xi/\xi - 1) \rightarrow 1$ as $\xi \rightarrow \infty$. The load resistance R_c, determined in this way is the lowest load resistance that can be used without making the input impedance R_i, negative. If lower values of R_c are used and an LC tank circuit is inserted across the input terminals in the base lead, the system will oscillate with the frequency determined by the tank circuit. The above graphical construction can then be used to determine both the critical

values of R_c required for oscillation, and the region in the dc collector characteristic plane in which the transistor may be made to oscillate (the region in which the critical value of R_c is greater than 0).

The region of possible oscillation in the dc collector-characteristic plane is bounded by a contour on which the points A and C of the construction of Fig. 3(b) coincide. If we define a current gain $\alpha=(\partial I_c/\partial I_e)_{V_c}$ (according to the literature)[3] we see that for $\alpha=1.0$ the above-mentioned coincidence occurs. The region of possible oscillation is then bounded by a contour of $\alpha=1.0$. Such a contour may easily be plotted by inspection since $\alpha=(\partial I_c/\partial I_e)_{V_c}=1.0$ means simply that the vertical separation of the constant-emitter-current lines should equal one unit on the collector current scale if the constant-emitter-current lines are drawn for the same units of emitter current.

In the more general case, we may bound the region of the collector characteristic plane in which ξ can be made equal to, or greater than, some desired value ξ_0. This means in the construction of Fig. 3(b) that the points A and D would coincide on this boundary when the length BC has been multiplied by $\xi_0/(\xi_0-1)$ to get the length BD. Such a condition is illustrated in Fig. 5. By similar

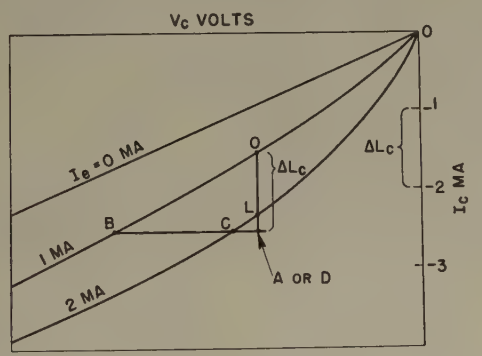


Fig. 5—Collector plane construction for the derivation of equation (17).

triangles, we see that

$$\frac{OL}{OD}=\frac{OL}{OA}=\frac{BC}{BD}. \tag{14}$$

By construction,

$$\frac{BC}{BD}=\frac{\xi_0-1}{\xi_0} \tag{15}$$

[3] See page 364 of footnote reference 1.

and by definition,

$$\alpha=\left(\frac{\partial I_c}{\partial I_e}\right)_{V_c}=\frac{OL}{\Delta L_c}=\frac{OL}{OA}. \tag{16}$$

Substituting (15) and (14) into (16), we get

$$\alpha=\frac{\xi_0-1}{\xi_0} \tag{17}$$

on the boundary of the region in which $\xi\gtreqless\xi_0$. This means, for instance, that if we want to design a current amplifier with a gain of 10, we must choose the operating point in the collector characteristic plane in a region where the $\alpha\gtreqless 0.9$.

In the region of oscillation discussed above, ξ is negative. All of the foregoing equations still hold for ξ negative, so that we may compute the negative input resistance R_i from (10) as easily as we may compute a positive input resistance. In designing a simple base-input trigger circuit, such as that discussed by Reich and Ungvary,[4] one may determine the lowest value of negative base input resistance obtainable with a given transistor by first picking the point of maximum α in the collector plane. This value of α determines in (17) the lowest possible value of $\xi=1/(1-\alpha)$. Next, the V_c ordinate through this point is transferred to the emitter plane and the slope of this transferred line is read at the same point, to obtain $\tan\eta$. The desired input resistance is then computed from (10) in the form

$$R_i=\frac{1}{1-\alpha}\left\{\frac{\Delta L_e'}{\Delta L_v}\tan\eta\right\}. \tag{18}$$

(Tan ζ and tan θ are both set equal to zero in this computation to find the lowest value of R_i possible.) If it is desired to have some resistance in the collector circuit, the value of ξ would have to be computed from (4).

These few examples should suffice to illustrate the graphical analysis of transistor characteristics for the design of simple circuits. Such methods are not easily extended to complex circuits, but the analysis of some types of more complex circuits (such as multistage amplifiers) can be done by these methods in successive steps.

ACKNOWLEDGEMENT

The author wishes to acknowledge his indebtedness to J. W. Coltman for suggesting the construction of Fig. 3(b), and for a helpful discussion of the work.

[4] H. J. Reich and R. L. Ungvary, "Transistor trigger circuit," *Rev. Sci. Instr.*, vol. 20, pp. 586–588; August, 1949.

Reactance Chart*

HAROLD A. WHEELER†, FELLOW, IRE

Summary—**The time-honored chart of reactance, frequency, inductance, and capacitance is extended in range, with added scales of susceptance, wavelength, and time constant. Simple geometric patterns are given which enable the chart to be used for the direct solution of various problems such as the bandwidth of a resonant circuit, some properties of a transmission line (wave impedance and delay), and half sections of the usual kinds of constant-k filters (low-pass, high-pass, band-pass).**

I. Introduction

SINCE 1928, the reactance chart has been one of the outstanding aids to radio engineers. It is here presented as Figs. 6 and 7 (see pages 1394 and 1395) with the following improvements:

1. A wavelength scale is added at the top of the chart giving a direct conversion between frequency and wavelengths.

2. A time-constant scale is added at the bottom, giving the time constant CR or L/R, or the time delay in a transmission line or filter.

3. A conductance or susceptance scale is added at the left side, the reciprocal of resistance or reactance.

4. The frequency scale of Fig. 7 covers from 0.1 cycle to 100,000 Mc (3 mm wavelength) in two ranges. The scales on the left side are common to both ranges. The other scales have upper and lower sets of units. All the upper units are used together for the low-frequency range, the lower units for the high-frequency range.

The following instructions describe the use of the chart in many problems, including the complete design of constant-k filters.

II. General Instructions

A point on the chart is the intersection of four lines, one each for frequency f, reactance X, inductance L, and capacitance C. Any two of these quantities determines the point and thereby the other two quantities.

Fig. 6 is a single square of the chart, enlarged for accuracy of reading. If accuracy is desired, the problem is first computed on Fig. 6, all except the decimal point. Then Fig. 7 is employed to locate the decimal point and to give a rough check on the number.

In locating a number on the inductance or capacitance scales of Fig. 6, it is important that the decimal point be shifted by an even number of places.

If accuracy is not required, only Fig. 7 is used. This is good for one or two significant figures and the decimal point is located in the numbers and units on the scales.

* Decimal classification: R145×R084. Original manuscript received by the Institute, February 13, 1950.

This paper was prepared while the writer was associated with Hazeltine Service Corp., Little Neck, L. I., N. Y. It was first printed in October, 1942, as Hazeltine Report 1400W.

† Wheeler Laboratories, Great Neck, L. I., N. Y.

III. Abbreviations

c = cycle per second
s = second
m = meter
Ω = ohm
℧ = mho
h = henry
f = farad
M = mega (10^6)
μ = micro(10^{-6}).

IV. Reactance and Resonance

Disregarding the sign of the reactance, the basic formulas for this chart are as follows:

$$X = \omega L = 2\pi f L \quad \text{ohms} \tag{1}$$

$$X = \frac{1}{\omega C} = \frac{1}{2\pi f C} \quad \text{ohms} \tag{2}$$

in which

X = reactance of L or C (ohms)
f = frequency (cycles per second)
$\omega = 2\pi f$ = radian frequency
L = inductance (henries)
C = capacitance (farads).

If L and C form a resonant circuit as in Fig. 1, these two formulas merge into the resonance formulas

$$X_0 = \omega_0 L = \frac{1}{\omega_0 C} = \sqrt{\frac{L}{C}} \quad \text{ohms} \tag{3}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad \text{radians per second.} \tag{4}$$

In which the subscript "0" denotes resonance.

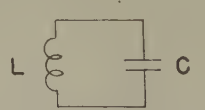


Fig. 1—Resonant circuit.

Fig. 2 shows the pattern representing the above four formulas for reactance and resonance.

The susceptance corresponding to reactance X is $B = 1/X$. This is given on the reciprocal scale on the left side.

The wavelength corresponding to frequency f is

$$\lambda = \frac{c}{f} = \frac{2\pi c}{\omega} \quad \text{meters} \tag{5}$$

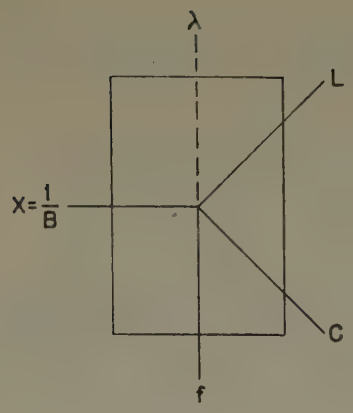


Fig. 2—Solution of reactance and resonance.

in which

$c = 3 \times 10^8$ meters per second
= 300 meters per microsecond
= speed of light.

V. Resistance and One Kind of Reactance

A combination CR or L/R behaves as a low-pass or high-pass filter. Fig. 3 shows the typical combinations of this kind. Each presents a voltage attenuation ratio of $1/\sqrt{2}$ (3 db) at a nominal cutoff frequency f_c such that

$$R = \omega_c L \quad \text{or} \quad \frac{1}{\omega_c C} \qquad \text{ohms.} \quad (6)$$

Fig. 4 shows the solution of this problem on the chart.

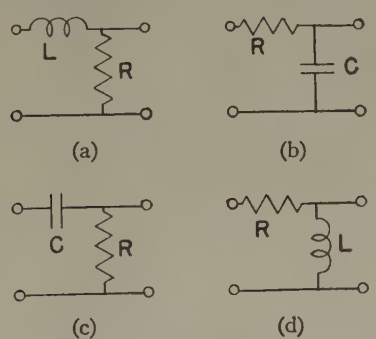


Fig. 3—Resistance and one kind of reactance: (a) and (b) low-pass; (c) and (d) high-pass.

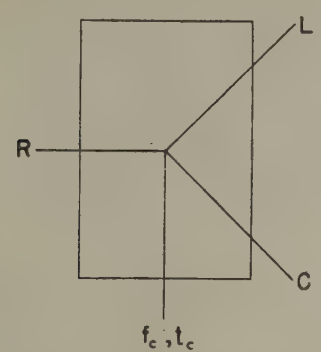


Fig. 4—Solution of low-pass and high-pass filters.

Each of the networks of Fig. 3 has a charging or discharging time constant

$$t_c = \frac{1}{\omega_c} = \frac{L}{R} \quad \text{or} \quad CR \qquad \text{seconds.} \quad (7)$$

An extra scale below the chart gives this time constant. It is noted that the subdivisions of this scale are provided by diagonal lines meeting to form a "V" at the bottom edge of the chart where each subdivision should be. The time constant is the radian period corresponding to the frequency.

VI. Resistance and Resonance

A sharply resonant circuit with resistance as shown in Fig. 5(a) behaves as a band-pass filter. Relative to the peak, it presents a voltage attenuation ratio of

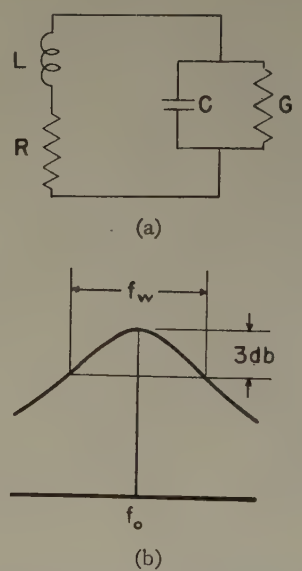


Fig. 5—Resistance in a resonant circuit.

$1/\sqrt{2}$ (3 db) at a nominal bandwidth f_w indicated in Fig. 5(b). The series R and shunt G contribute parts of the bandwidth as follows:

$$f_w = f_u + f_v \ll f_0 \quad (8)$$

$$\omega_u = \frac{1}{t_u} = \frac{R}{L}; \qquad \omega_v = \frac{1}{t_v} = \frac{G}{C} \quad (9)$$

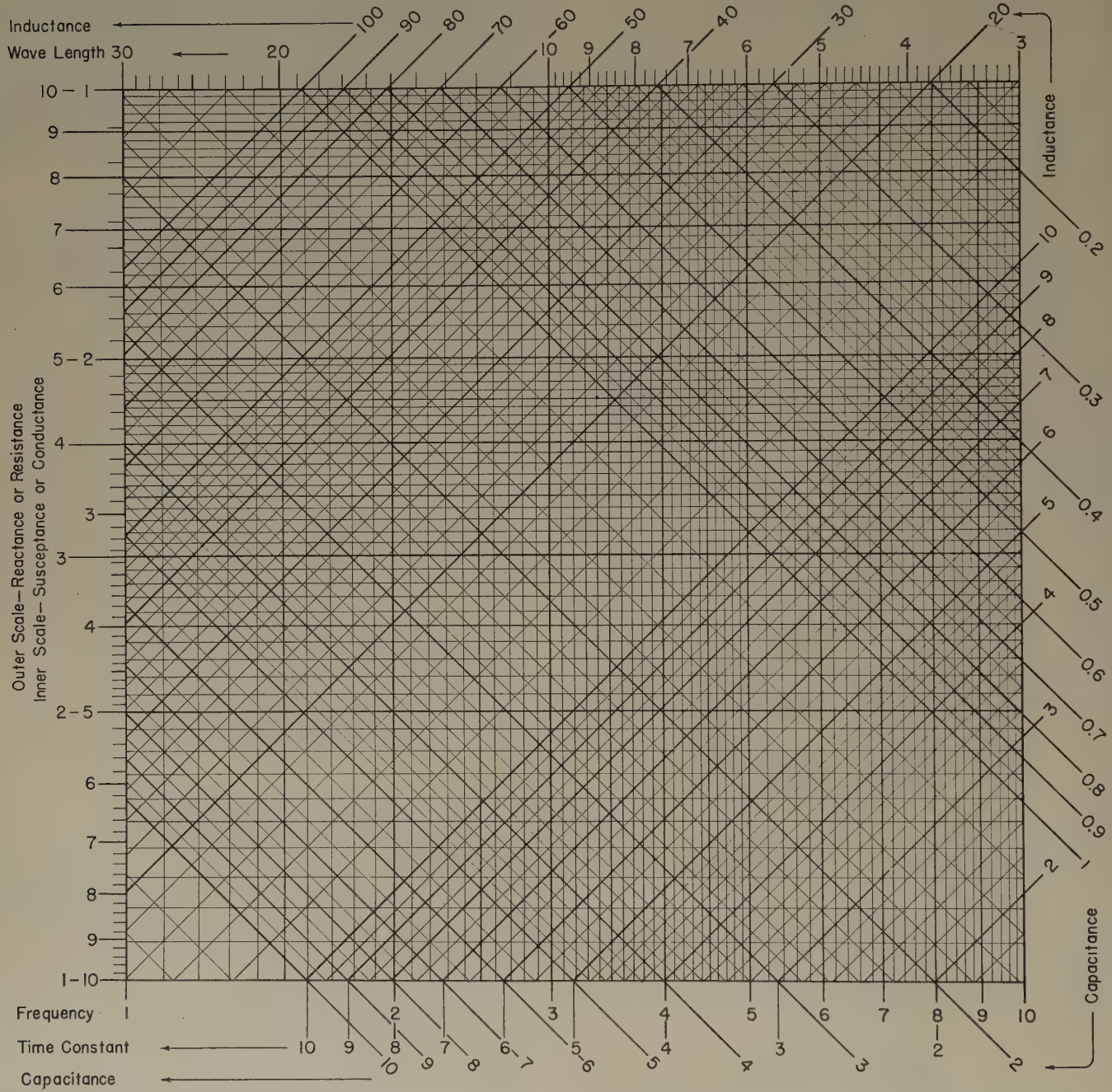
$$\omega_w = \frac{1}{t_w} = \frac{R}{L} + \frac{G}{C} \quad (10)$$

in which

t_u = time constant of L/R
t_v = time constant of C/G
t_w = half time constant of damping of free oscillations in the resonant circuit.

Fig. 8 shows the pattern of all these relations and others on the chart, involving five points of intersection. Since the bandwidth does not involve the frequency of

Note. On the scales of inductance and capacitance, both decimal points must be shifted by even numbers of places, or both by odd numbers of places, to interchange the scales on this chart with the actual values in henries (Mh, h, μh, μμh) and farads (f, μf, μμf, μμμf). This rule must be followed if both inductance and capacitance appear in the same computation.



$$X \text{ or } R = 2\pi fL = \frac{1}{2\pi fC} = \sqrt{\frac{L}{C}} = \frac{L}{t_c} = \frac{t_c}{C}$$

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{X}{2\pi L} = \frac{1}{2\pi CX} = \frac{1}{2\pi t_c} = \frac{300}{\lambda} \times 10^6$$

$$L = \frac{X}{2\pi f} = \frac{1}{4\pi^2 f^2 C} = CR^2 = Rt_c = \frac{t_c^2}{C}$$

$$t_c = \sqrt{LC} = \frac{L}{R} = CR = \frac{1}{2\pi f} = \frac{\lambda}{2\pi \times 300} \times 10^{-6}$$

$$C = \frac{1}{2\pi fX} = \frac{1}{4\pi^2 f^2 L} = \frac{L}{R^2} = \frac{t_c}{R} = \frac{t_c^2}{L}$$

$$\lambda = 2\pi\sqrt{LC} \times 300 \times 10^6 = \frac{300}{f} \times 10^6 = 2\pi t_c \times 300 \times 10^6$$

Fig. 6—Enlargement of one square.

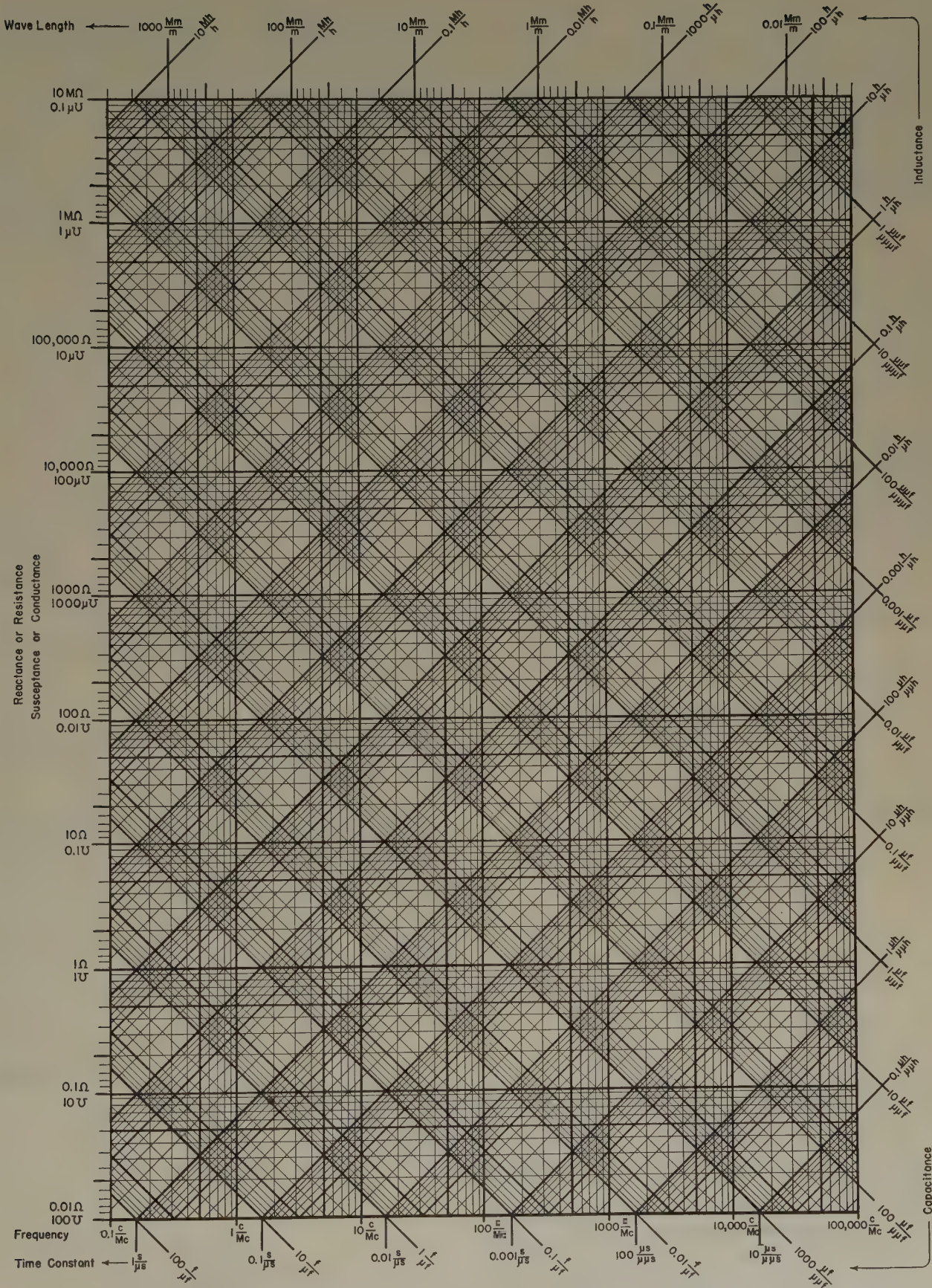


Fig. 7—Reactance chart.

resonance, the bandwidth may be determined separately.

The intersection of R and L determines f_u while that of G and C determines f_v. The sum of these is the nominal bandwidth f_w, which also determines the half time constant of damping, t_w on the time-constant scale.

The total effect of R and G may be regarded as concentrated in an equivalent series resistance R' or shunt resistance R'', such that

$$R' = \omega_w L \quad \text{or} \quad R'' = \frac{1}{\omega_w C}. \tag{11}$$

These formulas are closely associated with the ratio of reactance to resistance

$$Q = \frac{f_0}{f_w} = \frac{X_0}{R'} = \frac{R''}{X_0} \gg 1. \tag{12}$$

The equivalent series or shunt resistance, R' or R'', is determined by the intersection of f_w with L or C, respectively. This pattern of Fig. 8 gives a simple conversion between equivalent series and shunt resistance if either is given, together with L and C.

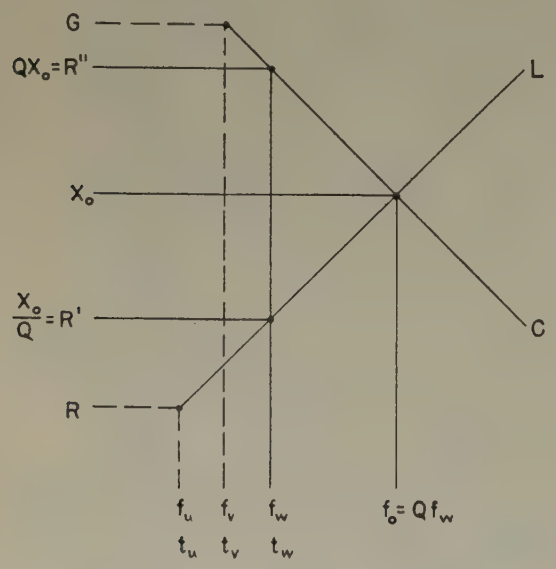


Fig. 8—Bandwidth of a resonant circuit.

The remaining point in Fig. 8 is the resonance point like Fig. 2. If either the series R or the shunt G is absent, this pattern simplifies by the disappearance of the dotted lines, because either f_u or f_v disappears and the other merges into f_w.

It may happen that the pattern of Fig. 8 for a given problem is divided between the two frequency ranges on the chart. This is true of circuits resonant in the neighborhood of 1 Mc. If many problems are to be encountered in such a region, a third scale may be added in red ink (or may be imagined) which is the mean of the two ranges marked on Fig. 7.

VII. Low-Pass and High-Pass Filters

Low-pass and high-pass filters of the constant-k type are shown in Fig. 9. The half section is the logical (but not usual) basis for filter design formulas, and is used in this treatment.

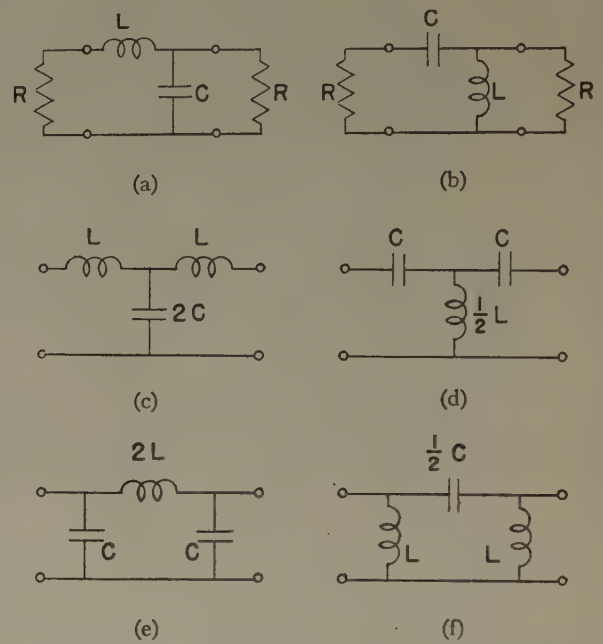


Fig. 9—Low-pass and high-pass filters to be solved by Fig. 4: (a) and (b) half sections; (c) and (d) mid-series sections; (e) and (f) mid-shunt sections.

On this basis, the low-pass and high-pass formulas are the same as (6) above, R being the nominal or "mid-band" image impedance. Therefore, these filters are designed directly by the pattern of Fig. 4.

In a low-pass filter, the time constant t_c is the delay per half section, based on the "mid-band" phase slope at frequencies much less than the cutoff frequency.

Either of these half-section filters with R on both sides is simply a critically damped resonant circuit whose frequency of resonance is f_c. Critical damping can be obtained by resistance on only one side of the half section if the value is changed to $2R$ in series or $R/2$ in shunt.

VIII. Band-Pass Filters

Band-pass filters of the constant-k type are shown in Fig. 10. If the cutoff frequencies are f_1 and f_2, the design formulas may be expressed as follows

$$\omega_2 - \omega_1 = \frac{R}{L_1} = \frac{1}{RC_2} \tag{13}$$

$$\omega_1\omega_2 = \frac{1}{C_1L_1} = \frac{1}{C_2L_2}. \tag{14}$$

These two expressions have in common L_1 and C_2. In (13) they are involved with R and the bandwidth f_2-f_1, and in (14) with C_1, L_2, and the mean frequency $\sqrt{f_1f_2}$.

These relations are respectively analogous to (11) and (4) above, from which follows the pattern of Fig. 11. The three points of intersection are determined by R, f_2, and f_1 in the usual practical problem, but the design is determined by any set of quantities sufficient to locate the three points. The pattern is shown for cases in which the bandwidth is less or greater than the mean frequency.

A band-rejection filter is computed by the same procedure, by merely interchanging the series and parallel arms in the half section of Fig. 10(a).

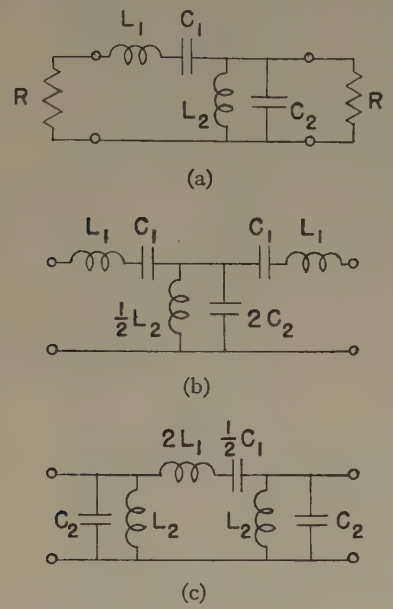


Fig. 10—Band-pass filters. (a) Half section. (b) Mid-series section. (c) Mid-shunt section.

IX. Transmission Lines

The transmission line of Fig. 12 has two characteristics of interest here, its wave impedance and its time of delay.

The wave impedance is

$$R = \sqrt{\frac{L}{C}} \tag{15}$$

in which L and C are uniformly distributed inductance and capacitance of any length of the line. This equation is solved by the pattern of Fig. 4.

The time of delay is

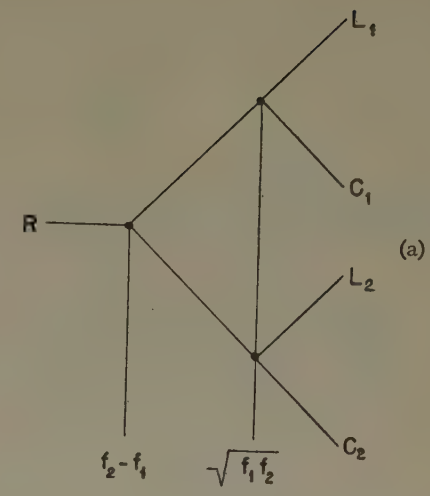
$$t_c = \sqrt{LC} \tag{16}$$

in which L and C are the total values for a certain length of line. This formula also is solved in Fig. 4.

Both of these formulas apply also to any number of sections of low-pass filter, L and C being the total series inductance and shunt capacitance.

Acknowledgment

The writer expresses his special appreciation of the skill and ingenuity of E. A. Owen in preparing the charts.



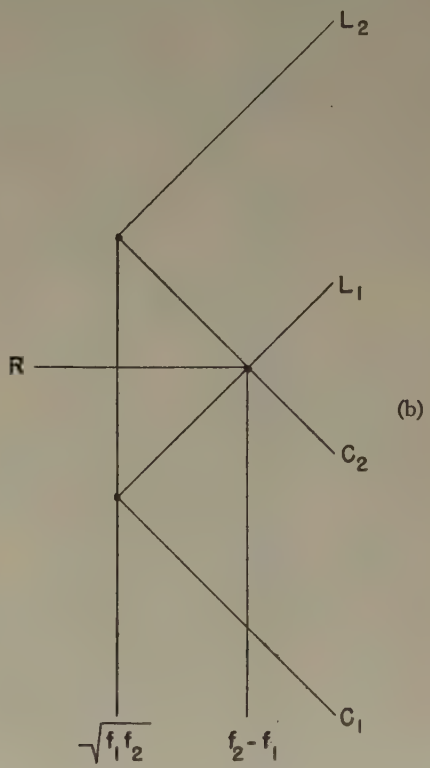


Fig. 11—Solution of band-pass filters.

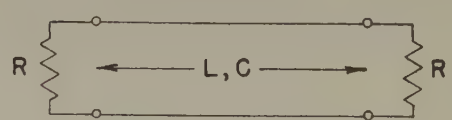


Fig. 12—Transmission line, to be solved by Fig. 4.

Bibliography

1. A. Hazeltine, "Electrical Engineering," Macmillan Co., New York, N. Y., chap. VI, pp. 210–249; 1924.
2. C. T. Burke, "Inductance-capacity-frequency-impedance chart," *Gen. Rad. Exper.*; June, 1928.
3. T. E. Shea, "Transmission Networks and Wave Filters," D. Van Nostrand Co., New York, N. Y., pp. 291, 306, 315–318; 1929.
4. H. W. Anderson, "A capacity, inductance and impedance conversion chart," *Radio Eng.*, vol. 11, p. 32; June, 1931.
5. T. Slonczewski, "A versatile nomogram for circuit problems," *Bell Lab. Rec.*, vol. 10, p. 71; November, 1931.
6. J. R. Tolmie, "Note on a modified reactance-frequency chart," Proc. I.R.E., vol. 21, pp. 1364–1366; September, 1933.
7. R. Lorenzen, "A–C Calculation Charts," 1942.

Inductance Chart for Solenoid Coil*

HAROLD A. WHEELER†, FELLOW, IRE

Summary—**A simple chart presents the relation between inductance, over-all dimensions, and density of winding for a solenoid coil. Any one unknown may be determined if the other quantities are given.**

I. Solenoid Coil

THE CHART to be described presents the relations among the dimensions and inductance of a solenoid coil. It presents them in such a form that any sufficient group of values may be given and the remaining values may be explicitly read from the chart. The chart is plotted on logarithmic scales covering a number of decades sufficient for nearly all applications of solenoid coils. The decimal point is placed so there is no ambiguity. The scale of winding density is self-computing for close windings of various wire gauges and types of insulation.

Fig. 2 (opposite page) is this chart, including a small diagram which shows the pattern of intersecting lines used for each computation. Fig. 1 shows a cross section of a solenoid coil with all dimensions noted, as follows:

Dimensions in Inches

a = mean radius of coil
$2a$ = mean diameter of coil
b = axial length of coil
c = depth of multilayer coil
d = diameter of wire
$e = 1/m = b/n$ = pitch of winding
$m = 1/e = n/b$ = density of winding
$n = b/e = mb$ = number of turns.

The chart is based on the usual current-sheet formula which is accurate for many turns of fine wire, close-wound in a single layer. It is also accurate at low frequencies for one turn or many turns of thin ribbon, close-wound in a single layer. The wire is made of non-magnetic material.

The following corrections are needed for special cases. The low-frequency cases apply if the current density in the wire is uniform. The high-frequency cases apply if the current flows in the surface of the wire, according to the skin effect.

II. Coil of One Turn

$$n = 1, \qquad m = 1/b, \qquad b < a.$$

This case may be computed, with an error less than 1/20 the value of inductance, by assigning the proper value to the axial length b; it is otherwise undetermined for one turn. Note that the two points of intersection on the chart are separated by one cycle on the horizontal scale.

At low frequencies, for solid wire:

$$b = e = \left(\frac{1}{2}\exp\frac{5}{4}\right)d = 1.74\,d; \quad d = 0.574\,b. \tag{1}$$

At low frequencies, for tubular wire of mean diameter $= d$; at high frequencies, for solid or tubular wire of outside diameter $= d$:

$$b = e = \left(\frac{1}{2}\exp\frac{3}{2}\right)d = 2.24\,d; \quad d = 0.446\,b. \tag{2}$$

At high frequencies, for ribbon of width $= d$:

$$b = e = \left(\frac{1}{4}\exp\frac{3}{2}\right)d = 1.12\,d; \quad d = 0.893\,b. \tag{3}$$

III. Coil of Few Turns

The accuracy of L is greatest if the ratio of pitch over wire diameter e/d has the value given in the preceding rules

IV. Multilayer Coil of Many Turns

For b, substitute $b+c$:

$$m = \frac{n}{b+c}; \qquad n = m(b+c). \tag{4}$$

The accuracy of L is within 1/20 if $c < a/2$.

Acknowledgment

The writer expresses his special appreciation of the skill and ingenuity of E. A. Owen in preparing this chart.

Bibliography

1. E. B. Rosa and F. W. Grover, "Formulas and tables for the calculation of mutual and self-inductance," National Bureau of Standards, Washington, D. C., Scientific Paper no. 169, pp. 116–126, 166–170; 1916.

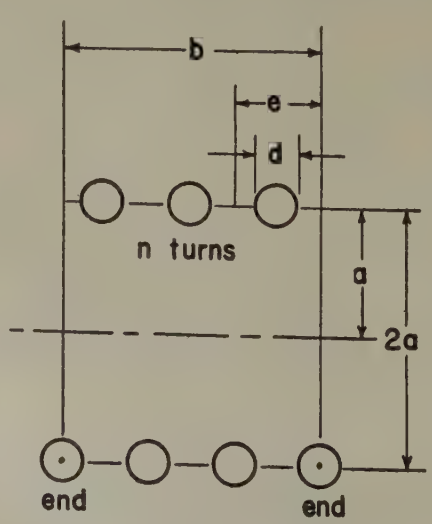


Fig. 1—Dimensions of solenoid coil.

* Decimal classification: R217.11×R382×R084. Original manuscript received by the Institute, February 13, 1950.
This paper was prepared while the writer was associated with Hazeltine Service Corp., Little Neck, L. I., N. Y. It was first printed in August, 1942, in Hazeltine Report 1343W.
† Wheeler Laboratories, Great Neck, L. I., N. Y.

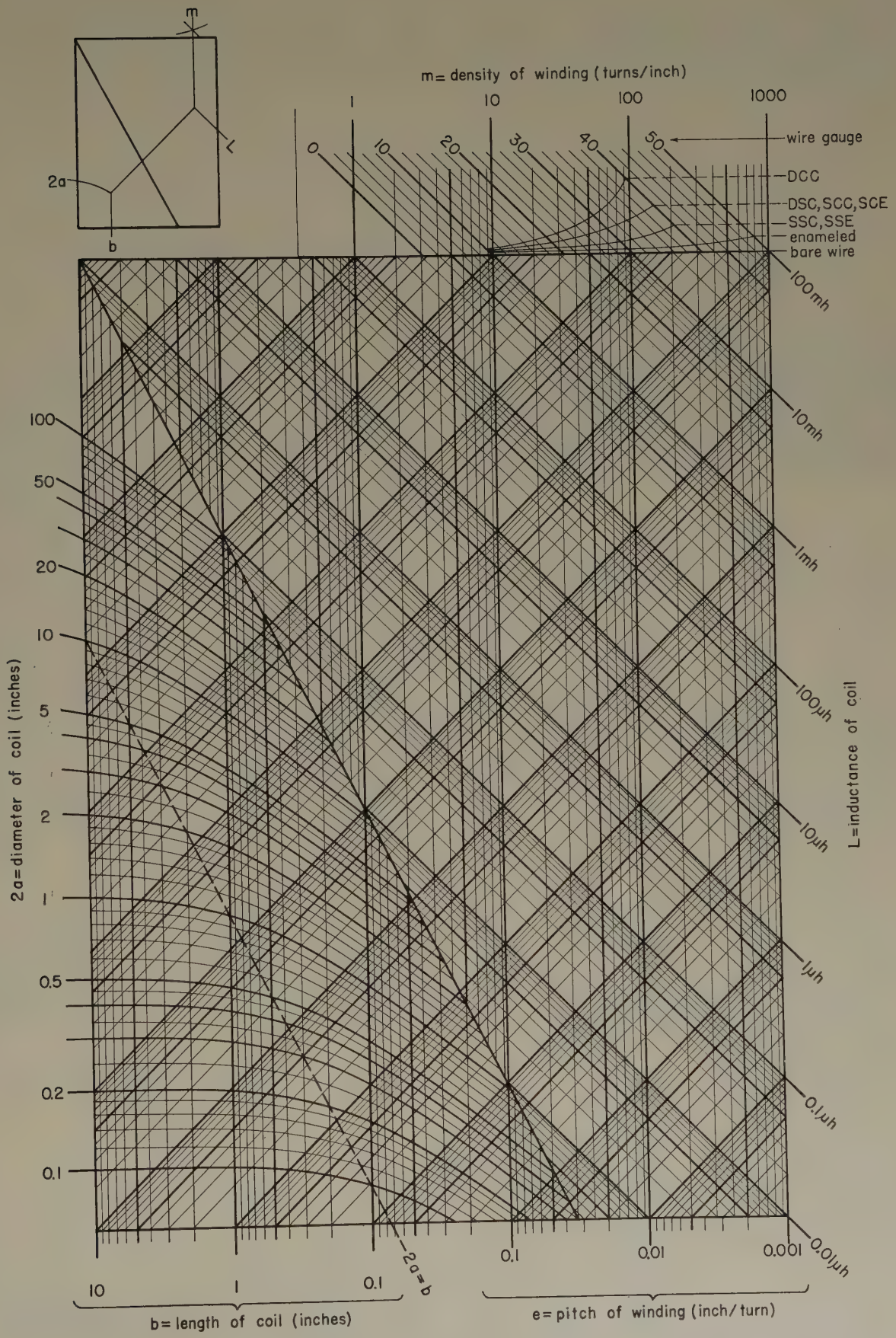


Fig. 2—Inductance chart.

2. National Bureau of Standards, "Radio Instruments and Measurements," Circular 74, p. 252; 1918 and 1924.
3. H. A. Wheeler, "Simple inductance formulas for radio coils," Proc. I.R.E., vol. 16, pp. 1398–1400; October, 1928.
4. G. P. Harnwell, "Principles of Electricity and Electromagnetism," McGraw-Hill Book Co., Inc., New York, N. Y., pp. 435–437; 1938.
5. H. A. Wheeler, "Effective radius of a cross-section," Hazeltine Report 1249W, Hazeltine Service Corp., Little Neck, L. I., N. Y.; September 22, 1941.
6. H. A. Wheeler, "Formulas for the skin effect," Proc. I.R.E. vol. 30, pp. 412–424; September, 1942.

Transmission-Line Impedance Curves*

HAROLD A. WHEELER†, FELLOW, IRE

Summary—**A universal family of curves gives on one plot the wave resistance, inductance, and capacitance of transmission lines of one or two or four wires. Each curve represents one field pattern. An expanded scale includes the region of very low impedance, usually neglected. The seven field patterns plotted include inner conductors of circular cross section, in or near shields such as a nearby plane, a corner, parallel planes, a trough, and a coaxial square or circle.**

I. Introduction

IN A TRANSMISSION LINE, the same field patterns are involved in the wave resistance (R) and the inductance and capacitance per unit of length (L, C). Also, every field pattern of a two-wire line (balanced pair) may be bisected by a plane so as to occur about a one-wire line. Hence, one curve can present all these properties of one or two wires. A family of such curves is given to present the properties of one or two or four wires in various shields formed of one or more planes or of circular cross sections. On semilogarithmic co-ordinates, all the curves approach parallel straight lines for high-impedance transmission lines.

II. The Family of Curves

Figs. 1 and 2 (see pages 1402 and 1403) present a family of seven curves plotted on two different scales. Fig. 1 is plotted on the usual semilogarithmic co-ordinates, so that a coaxial line of circular inner and outer cross sections is plotted as a straight line. Fig. 2 is plotted on a special scale which expands the region of low impedance and causes each curve to have a certain finite value of its slope at the origin.

Each curve corresponds to a shield cross section which has all of its surfaces tangent to a circular cross section. The diameter D thereof is denoted the "maximum wire diameter," because it is the wire diameter that would touch the shield. The inner conductor is a wire having a circular cross section of a lesser diameter d.

Table I is a list of the seven field patterns, (a) to (g), with their description for one, two, or four wires. On Fig. 1, they are diagrammed for one or two wires, in the same order as the curves from top to bottom.

Fig. 1 and Table I have a column of the factors s which are a measure of how much space outside the "maximum wire diameter" is still inside the shield. A high-impedance line in any of the various shields has the same impedance as if the shield had a circular cross section of a diameter sD exceeding the "maximum wire diameter" by this factor. Beside each factor s is the number of ohms (in parentheses) by which this factor increases the wave resistance of one wire.

The curves are based on a perfect conductor, so the current travels on the outer surface of the inner diameter d and on the inner surface of the outer diameter D. For imperfect conductors, the capacitance is the same, but corrections will be given for the inductance and wave resistance.

Also, the curves are based on free space, which is the same as air for the precision of this treatment. If the line is filled with an insulating material having a dielectric constant k, the capacitance is multiplied by k and the wave resistance is divided by $\sqrt{k}$.

III. The General Formulas

If the diameter ratio D/d is so large that the field pattern is substantially circular near the wire, the properties of the line are given by the following simple logarithmic formulas:

$$R = R_0 \frac{n}{m} \frac{\log sD/d}{2\pi}$$

$$L = \mu_0 \frac{n}{m} \frac{\log sD/d}{2\pi}$$

$$C = \epsilon_0 \frac{m}{n} \frac{2\pi}{\log sD/d}$$

in which

R = characteristic resistance (ohms)
L = inductance per unit length (μh per meter)
C = capacitance per unit length ($\mu\mu f$ per meter)
$R_0/2\pi = 60$ ohms
$\mu_0/2\pi = 0.2$ μh per meter

* Decimal classification: R244.2×R084. Original manuscript received by the Institute, February 13, 1950.
This paper was prepared while the writer was associated with Hazeltine Service Corp., Little Neck, L. I., N. Y. It was first printed in July, 1942, in Hazeltine Report 1336W.
† Wheeler Laboratories, Great Neck, L. I., N. Y.

$\epsilon_0(2\pi) = 1{,}000/18 = 55.5\ \mu\mu f$ per meter
n = number of wires in series
m = number of wires in parallel
s = shield factor (defined above)
D/d = diameter ratio (defined above)
log = natural logarithm = 2.303 $\log_{10}$.

If the diameter ratio is only slightly greater than unity, exact formulas are known for only two of the cases, (a) and (g). This region is left blank in Fig. 1, but in Fig. 2 is enlarged and plotted. The latter is based on interpolation formulas derived by the writer, which are asymptotic for diameter ratios near unity and near infinity; they are close approximations for all ratios.

IV. The Current Distribution in the Conductors

The following corrections for current distribution are valid if the diameter ratio is substantially greater than unity in the straight regions of the curves in Fig. 1.

If the depth of penetration δ, as determined by the skin effect, is less than one-quarter the thickness of a nonmagnetic conductor, the inductance and, hence, the wave resistance are subject to a simple correction. In computing the inductance, use the values

d = (outside diameter of inner conductor) $-\delta$
D = (inside diameter of outer conductor) $+\delta$.

No such correction is needed for the capacitance. Therefore the wave resistance can be computed by applying $\delta/2$, instead of δ, as a correction to each diameter.

If the depth of penetration is much greater than one-quarter the thickness of a nonmagnetic conductor, the current distribution is substantially uniform. For a thin-walled tubular conductor, use the mean diameters in computing the inductance

d = (outside diameter of inner conductor) − (thickness)
D = (inside diameter of outer conductor) + (thickness).

In computing the wave resistance, use one-half of each correction.

In the case of a nonmagnetic solid wire with uniform current distribution, the effective diameter for computing the inductance is

$d = 0.779$ (wire diameter)

and for computing the wave resistance,

$d = 0.882$ (wire diameter).

The amount of increase of inductance from this cause is indicated by a marker (*) on the scale. That of the wave resistance is one-half as high on the graphs, and is indicated by an extra horizontal line crossing the R scale near the bottom. These corrections are especially important if a line is to be tested at low frequencies and used at high frequencies

V. Bifilar Conductors

Case (a) for two wires is an example how equal currents in opposite directions cause the same field pattern as if a shield plane were interposed between the two conductors. Likewise, case (c) for one or two wires gives the effect of a grid of parallel wires with currents alternately in one direction and in the opposite direction.

The so-called Ayrton-Perry noninductive resistor is an example of such a grid of wires. Two wires connected in parallel ($n = 1$, $m = 2$) are wound "noninductively" in a single layer. Their inductance is one-half that of one wire on the graphs for case (c) with the added correction (*).

Acknowledgment

The author expresses his special appreciation of the skill and ingenuity of E. A. Owen in preparing these curves.

Bibliography

1. "High-frequency characteristic impedance of transmission lines," *Electronic Eng.* (London); July and September, 1941. (Several unusual cases.)
2. H. A. Wheeler, "Effective radius of a cross-section," Hazeltine Report 1249W, September 22, 1941. (Correction for uniform current distribution.)
3. S. Frankel, "Characteristic impedance of parallel wires in rectangular troughs," Proc. I.R.E., vol. 30, pp. 182–190; April, 1942. (Derivations of formulas for all cases, small wires.)
4. H. A. Wheeler, "Inductance of straight wires in rectangular shields," Hazeltine Report 1318W; June 9, 1942. (Small wires.)
5. H. A. Wheeler, "Transmission line impedance curves," Hazeltine Report 1336W; July 10, 1942. (The curves presented in this paper.)
6. H. A. Wheeler, "Formulas for the skin effect," Proc. I.R.E., vol. 30, pp. 412–424; September, 1942.
7. S. Frankel, "Characteristic functions of transmission lines," *Communications;* March, 1942. (Formulas for all cases, small wires.)
8. S. A. Schelkunoff, "Electromagnetic Waves," D. Van Nostrand Co., Inc., New York, N. Y.; 1943. (Two-dimensional stationary fields, pp. 173–187; small wire in rectangular shield.)
9. H. A. Wheeler, "Relations of C, L and R in a transmission line," Hazeltine Report 1534W; July 26, 1943.
10. W. B. Wholey and W. N. Eldred, "A new type of slotted line section," Proc. I.R.E., vol. 38, pp. 244–249; March, 1950. (Approximate formula for large wire between parallel planes.)

TABLE I

List of Field Patterns

Factor s	(Ohms)	One Wire	Two Wires (Balanced Pair)	Four Wires (Balanced Quad)
(a) 2	(41.5)	Near a plane	In open space	———
(b) $1.414 = \sqrt{2}$	(20.8)	In a corner	Near a plane	In open space
(c) $1.273 = 4/\pi$	(14.5)	Between two planes	Between two planes	———
(d) $1.2 = 6/5$	(10.9)	In a semicircular tube	In a circular tube	———
(e) $1.170 = (4/\pi)\tanh(\pi/2)$	(9.4)	In a channel	In a channel	Between two planes
(f) 1.079	(4.5)	In a square tube	In a rectangular tube	In a square tube
(g) 1	(0)	In a circular tube	In two circular tubes	In four circular tubes

Note—Since the four wires are connected in series-parallel, they take the same scales as one wire on the graphs.

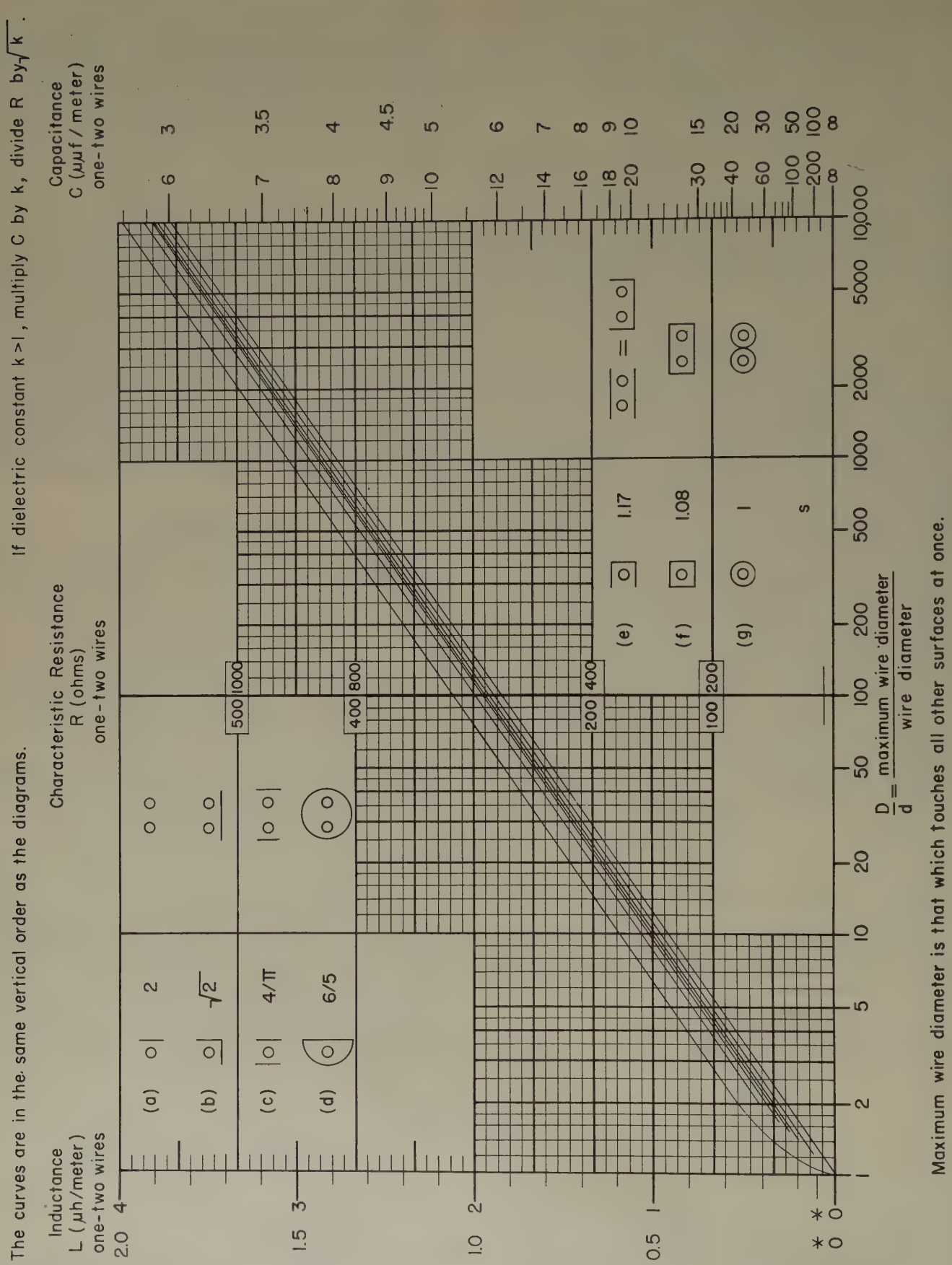


Fig. 1—Curves of wave resistance, inductance, and capacitance.

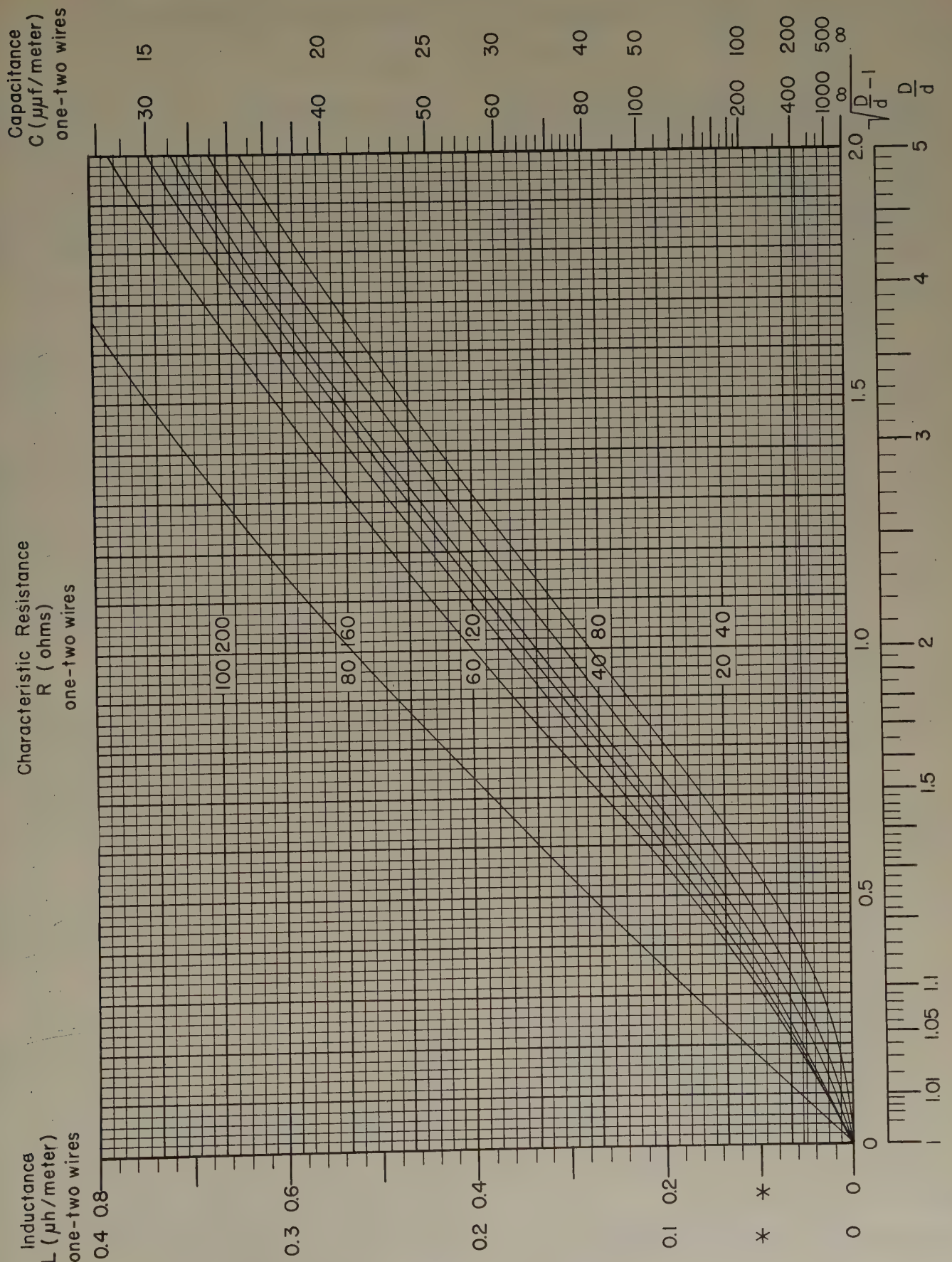


Fig. 2—Curves for lines of low impedance.

The Simplification of Television Receivers*

W. B. WHALLEY†, ASSOCIATE, IRE

Summary—**The minimum number of functions required in a TV receiver is analyzed with the purpose of reducing the required components and tubes while maintaining high quality of performance and all normally desirable features such as AGC and horizontal AFC. One of the approaches to this end has been a study of the feasibility of combining different functions in a common tube. A receiver incorporating some of the results of this study is described. Measured data taken on this receiver are presented and its general features are discussed.**

THIS PAPER, as the title indicates, describes an investigation into the general means of simplifying television receivers so as to reduce the costs of production and servicing. An account is given of several approaches to the problem which were found valuable in attaining the objectives.

Reasons for Simplification

There are many reasons for considering the possibilities of simplifying television receivers. Some are, of course, obvious since a reduction in the number of components has a cumulative effect in reducing the number of leads and connections, permits the use of a smaller chassis and cabinet, and requires less power and consequently smaller power transformers, filter capacitors, and choke.

In addition, however, there can be an improvement in reliability and ease of servicing as the number of components and related connections is reduced. This paper may, therefore, be regarded as describing an inevitable trend in the industry.

General Procedure

The first step in this program was to analyze the operation of a television receiver from the standpoint of the minimum number of necessary functions, and then to plan the simplest possible circuit to perform each function, at the same time keeping in mind the possibility of combining two functions in the same circuit.

In parallel with the analysis, a survey of the circuits of contemporary television receivers was made and trends in simplification noted.

It should be emphasized that the study program and the experimental work were predicated on designs having full bandwidth (4 Mc), good sensitivity, magnetic-type deflection circuits with horizontal automatic-frequency control, automatic gain control with moderate speed of response controlled from the video back-level voltage, good brightness such as that given by a 12½-inch picture tube operating at 10,000 volts, low hum level, and good sound quality.

* Decimal classification: R583.5. Original manuscript received by the Institute, January 9, 1950; revised manuscript received, July 5, 1950.

This paper is reprinted from *The Sylvania Technologist*, January, 1950.

† Sylvania Electric Products Inc., Bayside, L. I., N. Y.

It was also realized that, while considering the design changes in one section of the receiver, it was of major importance to relate such changes to the combination of circuits making up the whole receiver.

Experiments were then performed to test the new simplified circuits for the individual and combined functions, followed by the construction of a sample receiver incorporating several of the ideas evolved.

It may be advisable at this point to review briefly the functions of a television receiver in order that the discussion to follow may have better coherence. The various functions will be noted in a sequence which follows, as closely as possible, the path of the signal through the the receiver. Some general remarks as to the simplification and combination will be included.

1. Channel Selection and Radio-Frequency Amplification

Much work has been in progress on tuners, and there are available two or three types having reasonably good image rejection and noise figure, yet requiring only two tubes. It is probable that the circuit suggested by Wallman, Macnee, and Gadsden[1] would give a better signal-to-noise ratio than presently available tuners and yet still require a total of only two tubes.

2. Amplification at Intermediate Frequency

Intermediate-frequency amplifiers can operate with the fewest components if a basic design is chosen having one main unit to handle the sound by the intercarrier method. Stagger-tuned intermediate-frequency amplifier circuits have been quite popular during the past few years but are difficult to design for optimum adjacent-channel selectivity combined with good gain per stage. Measurements have shown that a modified bandpass-filter-coupled amplifier can give better adjacent-channel selectivity than stagger-tuned amplifiers and a sufficient increase in gain per stage to provide quite good operation with only three stages.

3. Video Detection

Video detectors are almost invariably of the single-diode type and are, therefore, about as simple as can be devised. We have found that a crystal diode, such as type 1N34, has some operating features which are a distinct improvement over available tube diodes. The crystal diode has low capacitance, linear output to low signal voltages, and is very easily wired into the circuit. It may be noted in passing that the high distortion which occurs in a sound AM receiver diode detector at modulations over 80 per cent is not a problem in a television receiver demodulator. This is due to the fact that the dc and ac loads are alike.

[1] H. Wallman, A. B. Macnee, and C. P. Gadsden, "A low-noise amplifier," PROC. I.R.E., vol. 36, pp. 700–708; June, 1948.

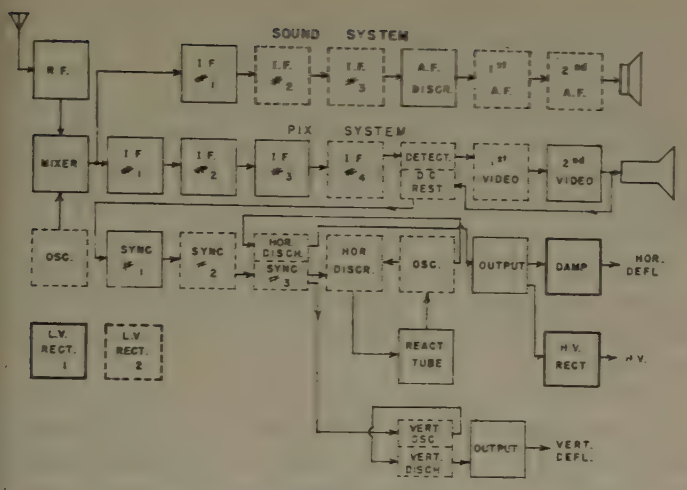


Fig. 1—Block diagram of a typical post-war good-quality receiver. Note—No AGC.

4. *Video Amplification*

The video signal for the picture tube could be supplied directly from the video detector if a high-level-output intermediate-frequency amplifier is chosen. This would also take care of the dc level. However, better gain-bandwidth figures are obtained in practice in a video amplifier than in an intermediate-frequency amplifier, and a large tube would have to be used in the final stage of the intermediate-frequency amplifier in order to supply 50 or more volts root-mean-square to the diode. Hence, a video amplifier having only one stage seems advisable. It is possible to design the video amplifier so that it takes care of the dc level control by the choice of a dc coupled circuit, provided that the reference dc point is stable during changes in amplitude of the received signal.

Maintenance of the dc level is most important, otherwise the background of the picture would change in intensity with change in the scene.

5. *Direct-Current Level Control*

Direct-current level control by the method of dc coupling the video amplifier eliminates the need of an extra diode and makes it possible to incorporate some noise limiting if the polarity of the video detector is suitably chosen.

6. *Gain Control*

It was realized that an automatic gain control circuit of good quality would be of major importance in receiver operation. A satisfactory automatic gain control (AGC) would lessen the need for adjusting the contrast control during tuning, would further stabilize the amplitude of pulses, and would avoid the overdrive and underdrive output settings of the manually operated receiver which can so often occur during switching of signals of widely different voltage levels. It was also known that simple types of automatic *volume* control circuits were inadequate since they responded directly to noise and interference voltages and also tended to upset the dc level control. Hence, the objective became a circuit which would produce a controlled voltage referred in amplitude to the black level of the signal.

7. *Sound Intermediate-Frequency Amplification*

The sound system which appears to give the greatest ease in tuning with a reasonably small number of components is the intercarrier system. With this type of operation it is usually permissible to employ only one stage of amplification at the frequency of 4.5 Mc. Aside from the adequacy of the single stage, there is greater ease in tuning the receiver since the fine tuning control is used only for obtaining the best picture quality and has little effect upon the sound. As has often been pointed out, there is the added freedom from the effect of local oscillator drift, oscillator tube microphonism, and hum.

8. *Discriminator*

The sound discriminator may be of various types. However, the ratio detector provides a relatively high audio-frequency output for the 25-kc FM deviation occurring in television sound operation and is reasonably stable in tuning.

9. *Audio Amplifier*

Preliminary analysis of the audio amplifier indicated that more than one stage is advisable. The usual procedure has been to use two separate tubes for this function. It appeared possible to combine this function with other portions of the receiver. As will be shown later, this has been tried out and a high degree of success has been obtained.

10. *Synchronizing Pulse Amplification and Separation*

Various types of synchronizing pulse amplifiers and separation circuits can be devised. The one chosen in this experimental work has no particular novelty except some reduction in the number of resistors. It seems that a double-triode tube should be sufficient for good synchronizing signal separation, especially if the input signal is obtained from the AGC peak voltage diode. This will be described at a later point.

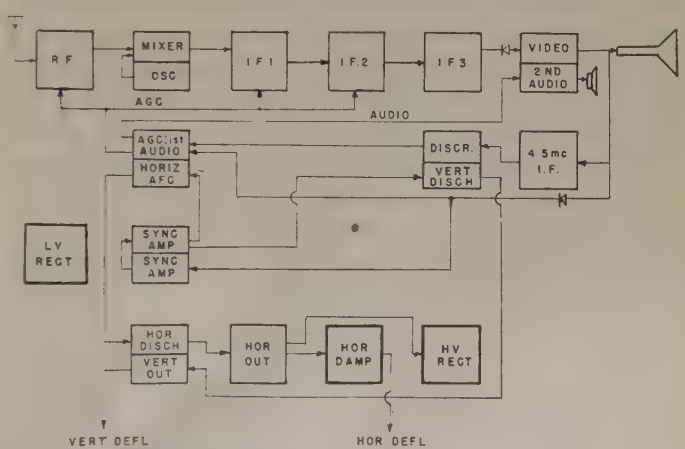


Fig. 2—Block diagram of a simplified receiver.

11. Horizontal Deflection

Horizontal deflection, preferably with automatic frequency control (AFC), is one function which lent itself to a considerable degree of simplification. Receivers have been constructed with four to eight tube sections to perform this operation. Clark[2] has called attention to the fact that there are three principal AFC circuits in use. These are the saw-tooth type, the sine-wave type, and the pulse-time type. The last one appears to require the smallest number of elements of those presently in use. Sufficient work has been done during the progress of this study to indicate that horizontal deflection with stable AFC might be obtained with a total of only two tubes.

12. Vertical Deflection

The status of vertical deflection has already attained considerable simplicity. Use of one double triode now appears sufficient for vertical deflection, including both saw-tooth generation and amplification.

13. High-Voltage Supply

Various sources of high voltage for a television receiver may be employed, for example, (a) a 60-cycle transformer, (b) a radio-frequency high-voltage supply, or (c) the horizontal-deflection amplifier pulse. Source (c) is most attractive for a number of reasons such as the following:

A. Very little shielding is required since the pulse is automatically in synchronism with the picture horizontal deflection.

B. There is a useful degree of automatic regulation of picture size as the line voltage varies.

C. The circuit is simple since it requires only the addition of a rectifier tube, filter resistor, and capacitor.

D. Finally, there is automatic protection of the picture tube if horizontal deflection fails.

14. Low-Voltage Supply

It should be pointed out that even the low-voltage power supply to a television receiver can be simplified. One item to be stressed is that, almost without exception, the rectifier choke has been placed in the positive side of low-voltage power supplies in television receivers. Tests show that there is no logical objection to putting the filter choke in the negative side, for example, from the center tap of the power transformer to ground. With this connection, the voltage drop across the choke and focus coil, if there is an electromagnetic focus coil, may be used for the negative dc supply, avoiding the use of a separate rectifier tube or the wasted voltage drop in an additional resistor which might be used in the return lead from the power transformer.

Dual Functions

Next comes the possibility of combining two functions in the same tube. Some of these possibilities have already been mentioned, such as the use of one double triode for the whole vertical deflection.

Thought was given to other possible combinations of functions, such as adapting a portion of the intermediate-frequency amplifier to serve also as the first sound amplifier, then using the AGC tube to serve also as part of the synchronizing circuit and, finally, to using the AGC tube to function also as the first audio amplifier.

The characteristics of various standard tubes were studied to see if one double-purpose tube could operate as the combined video amplifier and the final audio output stage.

The experimental part of the program was begun with measurements of the type 28D7 tube for its possible use in a combined audio-output stage and the whole video amplifier. These measurements showed that the tube had excellent characteristics as a video amplifier, operating with the cathode tied to ground and the control grid directly connected to a negatively polarized diode second detector. When dc coupled from the anode filter to the cathode of the picture tube, the voltage gain is 20 with a bandwidth of 4 Mc.

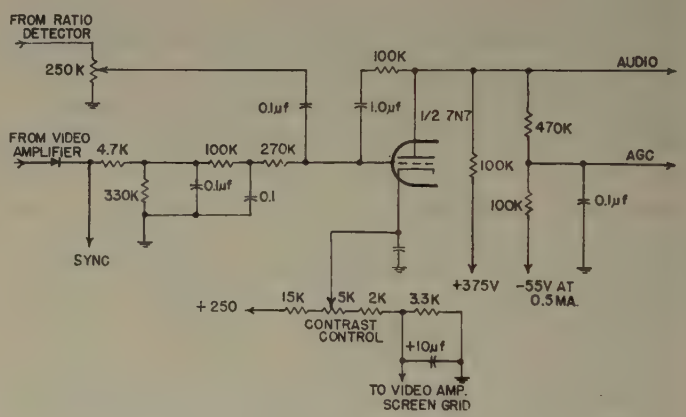


Fig. 3—Schematic of combined AGC and first audio amplifier using one half of a type-7N7 tube.

While one section of the tube is amplifying the video signal, the other section of the tube easily supplies 3 watts of audio power. These operating conditions are with a screen grid voltage of 33 and a total screen current of only 0.4 ma. Combining the video amplifier and audio output in a single tube means one less socket with correspondingly fewer pin connections.

One might be curious as to possible cross talk inside the tube envelope between the video and the audio signals. Careful measurements of a number of tubes show that the cross talk is quite low, averaging 70 db down.

We were interested in the possibility of combining the last intermediate-frequency amplifier and first audio stages. Measurements showed that this combination in the one tube has only one major objection—a high noise component in the received signal, particularly automobile ignition noise, will be superimposed upon the sound.

A new AGC circuit was developed for operating from the black-level voltage of the video signal with a negligibly small power consumption from the negative bias

[2] E. L. Clark, "Automatic frequency phase control of television sweep circuits," Proc. I.R.E., vol. 37, pp. 497–500; May, 1949.

supply. Thought was given to the possibility of also supplying some sync amplification. The first two items were attained by a new circuit which was developed during the experimental work and which is shown in Fig. 3. However, instead of combining the AGC with the sync amplifier, it was found to be, in general, preferable to make it serve the dual purpose of AGC and first audio amplifiers. In this way, one half of a type-7N7 double triode operates as a stable automatic-gain-control amplifier and, at the same time, as the first stage of the audio amplifier. The other half of the double tube can be used as part of the horizontal-deflection system.

Enough work has been done on a combined horizontal-deflection and automatic-frequency-control circuit to show the possibility of performing this combined function with fewer than 3 tubes. This work, however, has not yet been completed.

Simplification of the low-voltage power supply has resulted in one model which provides, from only one rectifier and a single filter choke, the main positive dc voltage and two negative voltages, one for the AGC amplifier divider, the other for biasing the final audio stage. The total filter capacitance is approximately one half that of conventional television receivers and the hum voltage is lower than that of any other television receiver that we have measured.

Additional items considered included the possible reduction in the number of resistors and capacitors in the synchronizing separation circuits. One result was a low-pass filter for the vertical integrating network having a total of two resistors and two capacitors which gave a steeper pulse output than older, more complex networks.

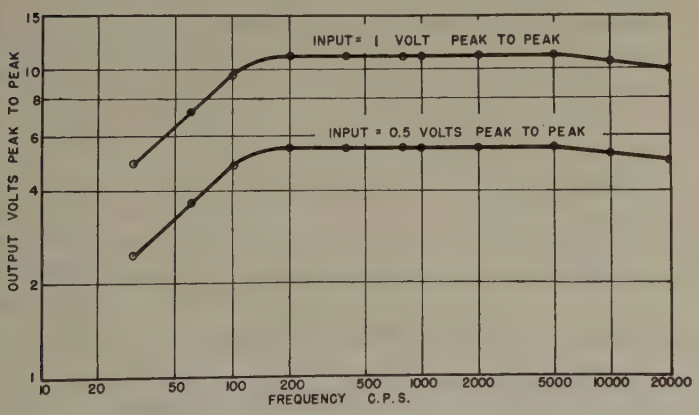


Fig. 4—Audio-frequency response curve of first audio and AGC.

Description of Sample Receiver

Having briefly described some of the experiments performed to date, a short description will be given of a completed sample receiver incorporating some of the features described.

Fig. 1 is the block diagram of a type of circuit which was very popular in 1948. In this diagram, the rectangles with heavy boundaries represent the rectifiers and the rectangles with dotted outlines are of those sections which have been removed or combined with other functions in one of the simplified receivers. The fact that both stages of the audio amplifier have dotted outlines is due to their combination with other functions and not to the elimination of the audio amplifier. It should be noted that this receiver does not have automatic gain control.

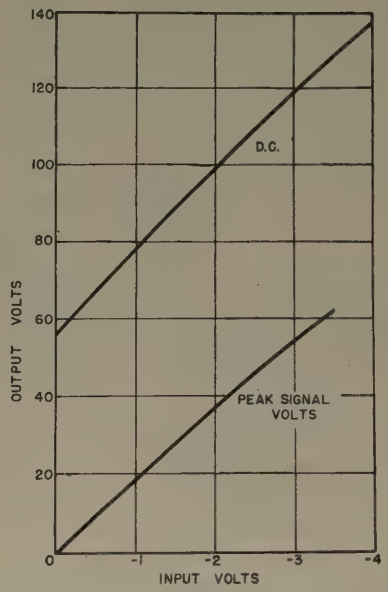


Fig. 5—Video gain characteristic of 28D7 tube, one section only. Zero-signal bias = 0, screen voltage = 33.

Fig. 2 shows the basic block diagram of a simplified receiver. The tuner uses a total of only two tubes, yet it has good image selectivity and a reasonably high signal-to-noise ratio. The intermediate-frequency amplifier has three stages of simple bandpass-filter coupling giving a voltage gain of 1,500. A tube similar to type 28D7 employing a 6.3-volt heater is used for the video amplifier and second stage of audio. For best operation a type-1N34 crystal is used as the second detector, although this could be replaced with one half of a type-6AL5 tube with some deterioration in operation. The intercarrier intermediate-frequency amplifier feeds the double-diode section of a type-7X7 or a 6T8 tube, while the triode section of this same tube produces the vertical sawtooth signal which is then amplified by one section of a 7N7, the other section of this latter tube providing the horizontal discharge for the horizontal-deflection amplifier stage. One section of another double triode operates as the combined AGC amplifier and first audio stage while the other section provides horizontal automatic frequency control. The synchronizing amplifier, as has been mentioned before, is one of several possible, circuits using a double triode, the design of this particular circuit being influenced by the plan for a minimum number of components.

Fig. 3 shows the detailed schematic of the combined AGC first audio unit.

Fig. 4 shows the audio-frequency response curve of

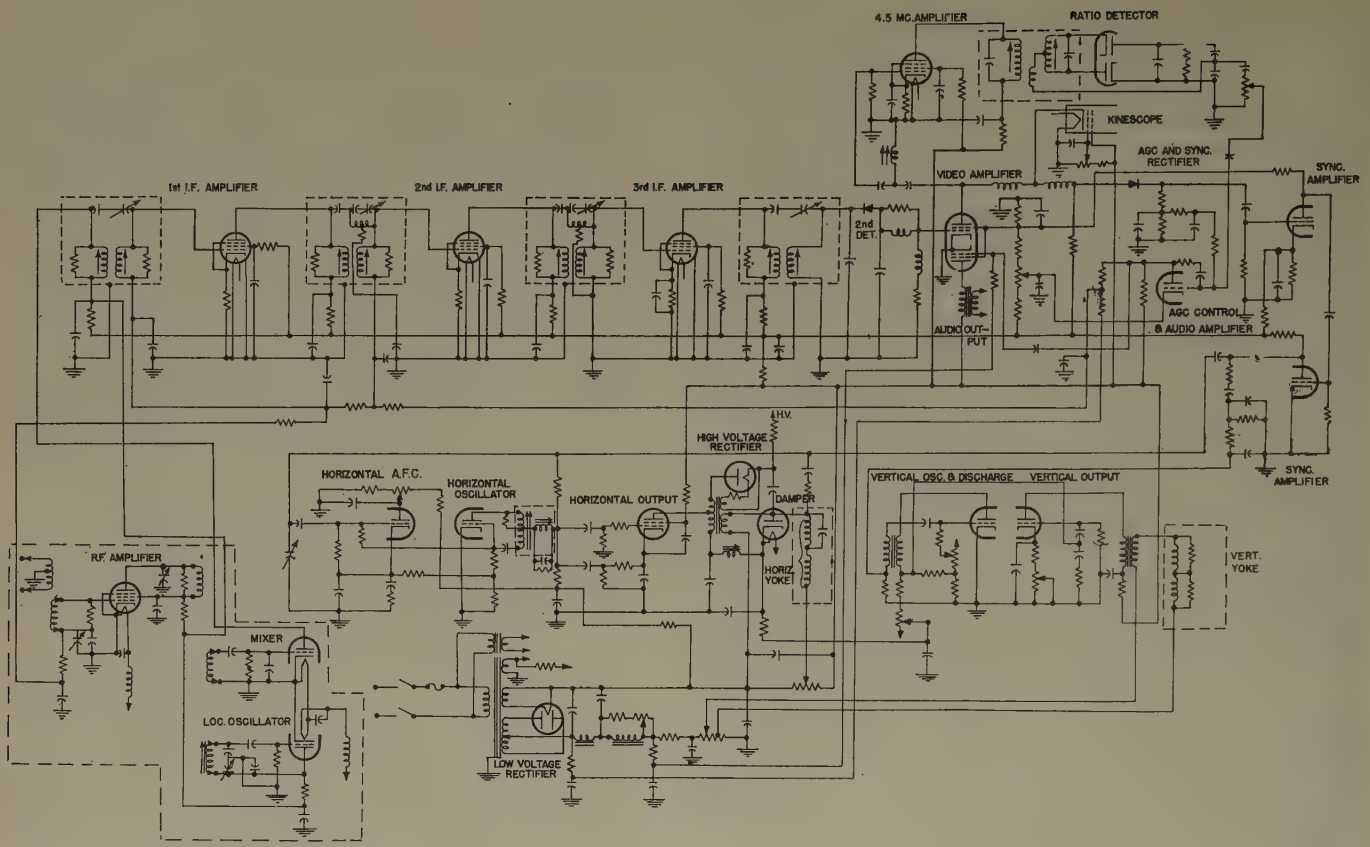


Fig. 6—Schematic of a complete simplified receiver.

the combined first audio and AGC amplifier. It will be noted that the frequency response is adequate for sound reproduction of reasonably high quality.

Fig. 5 shows the gain characteristic of one section of a type-28D7 tube used as a video amplifier.

Fig. 6 shows the over-all schematic for one of these receivers having 6 fewer tubes than the average good television receiver employing magnetic deflection. As mentioned previously, the two crystals could be replaced by one double-diode tube, although the improved operation obtained with the crystals and the simplicity in wiring would thereby be sacrificed.

Universal Design Curves for Intermediate-Frequency Amplifiers with Particular Reference to Phase and Amplitude Distortion and Their Compensation*

W. HACKETT†

Summary—The accurate assessment of distortion in intermediate-frequency amplifiers and the possibilities of compensation assume importance for the development of frequency-modulated very-high-frequency multi-channel equipment with its concomitant wide bandwidths. The present purpose is to furnish graphical data for the evaluation of phase and amplitude distortion arising from various types of coupling network including compensating combinations, to demonstrate a graphical procedure for accurate design, and to summarize the analysis on which the graphical treatment is based.

Sets of nomograms and curves provide for the assessment of performance as represented by gain times bandwidth, and for the interpretation of equation parameters in terms of circuit parameters.

* Decimal classification: R363.13. Original manuscript received by the Institute, July 7, 1949; revised manuscript received, August 8, 1950.

† British Telecommunications Research Ltd., Taplow, Bucks., England.

I. Introduction

FOR LOW HARMONIC DISTORTION in frequency modulation systems, small amplitude and phase distortion, particularly the latter, are essential. The use of tuned circuits as the coupling networks in intermediate-frequency amplifiers gives rise to both types of distortion. The purpose of the present study is to provide data in graphical form to facilitate the design of intermediate-frequency amplifiers of sufficiently low distortion.

For wide bandwidths, small distortion requires relatively low Q circuits which will usually be achieved by the shunt connection of resistance. Attention has, therefore, been confined throughout to parallel-loaded tuned circuits. At the same time it has been assumed that the carrier frequency is located at the point of phase symmetry, which for parallel-loaded circuits occurs at a frequency slightly different from the resonant frequency and requires some detuning.

For coupling networks comprising either single- or coupled-tuned circuits, a rigorous treatment leads to complicated equations for phase and amplitude distortion. Simple approximate equations are given which can be shown to represent phase distortion to a high degree of accuracy and amplitude distortion to a rather lower degree of accuracy for a single-tuned circuit. It is then shown that, under certain conditions, one stage comprising a pair of coupled-tuned circuits is substantially equivalent in respect of distortion to two stages of single-tuned circuits in which the resonant frequencies are staggered above and below the carrier frequency. This equivalence leads to the derivation of relatively simple, approximate equations for the distortion arising from coupled-tuned circuits in terms of equation parameters which differ somewhat from those adopted for series-loaded circuits or circuits of high Q.[1-3]

It is known that, over a certain range of parameters, coupled circuits exhibit amplitude and phase distortion of opposite sign to those obtaining with single-tuned circuits. This fact may be utilized to achieve a considerable measure of compensation by the cascade connection of stages embodying single- and coupled- or staggered-tuned circuits when the circuit parameters are suitably chosen. The requirement is therefore to present the data for the two characteristic types of distortion in such a form as to assist the optimum choice of parameters and permit the quantitative assessment of distortion in compensating combinations.

II. List of Symbols

$A = [-jk\ 2\pi f_{rc}^2 (C_1 C_2)^{1/2}]/f(1-k^2)$ (equation (10))
C = capacitance of tuned circuits in farads
C_e = equivalent capacitance per stage of unit network in farads
D_a = amplitude distortion per unit network in decibels
D_p = phase distortion per unit network
f = frequency in cps
f_0 = carrier frequency in cps
f_l, f_u = lower and upper values of f corresponding to given amplitude distortion for single-tuned circuits as rigorously derived
f_r = resonant frequency of tuned circuit in cps
Δf_r = error in f_r
F_e = equivalent gain factor per stage of unit network
g = mutual conductance of tube in amperes per volt
G = stage gain
G_e = mean or equivalent gain per stage of unit network
$J = K_1/2Q_s$
k = coefficient of coupling
k_c = coefficient of critical coupling
$K_1 = Q_c[(1-k)^{-1/2} + (1+k)^{-1/2}]$ for coupled-tuned circuits,
$= Q_2 + Q_1$ for staggered-tuned circuits
$K_2 = Q_c[(1-k)^{-1/2} - (1+k)^{-1/2}]$ for coupled-tuned circuits,
$= Q_2 - Q_1$ for staggered-tuned circuits
n_s = number of stages per unit network
n_u = number of unit networks
Q = magnification factor of tuned circuit at resonant frequency
$x = F_e(f-f_0)/f_0$
Z = transfer impedance of coupling network of one stage
Z_e = equivalent transfer impedance per stage of unit network
$\lambda = K_1(f-f_0)/f_0$
$\Delta\lambda$ = error in λ corresponding to error Δf_r
λ_a = value of λ corresponding to peak values of D_a (Fig. 2)
λ_p = value of λ corresponding to peak values of D_p (Fig. 1)
ϕ = phase shift associated with unit network
ϕ_0 = value of ϕ at $f = f_0$.

TABLE I

Suffixes	Refer to
1, 2	Individual equivalent and/or actual tuned circuits involved in coupled or staggered circuit networks.
c	Coupled-tuned circuits.
s	Single-tuned circuits.
st	Staggered-tuned circuits.
s/c	Compensating combination comprising single- and coupled-tuned circuits.
s/st	Compensating combination comprising single- and staggered-tuned circuits.

[1] K. R. Sturley, "Radio Receiver Design," Chapman and Hall, London, England, Part I: p. 301, Part II: p. 377; 1947.
[2] R. T. Beatty, "Two-element band-pass filters," *Wireless Eng.*, vol. 9, p. 546; October, 1932.
[3] R. T. Beatty, "Radio data charts" (4th edition, revised by J. M. Sowerby), Iliffe, London, England, p. 41; 1945.

III. Definitions

Unit Network

It is found convenient to define and express distortion in terms of the "unit network," which is defined as the smallest repeatable combination of stages n_s in the amplifier.

Performance Parameter P

Assuming a constant current source such as a pentode, the ratio of output to input voltage of an amplifier stage is given by gZ, where g is the mutual conductance of the tube and Z is the transfer impedance of the coupling network. The stage gain G at the carrier frequency f_0 is then given by

$$G = g\,|\,Z\,|_{f=f_0}.$$

If the n_s stages of a unit network have transfer impedances $Z_1, Z_2 \cdots Z_{ns}$, then the mean or equivalent gain per stage G_e at the carrier frequency is given by

$$G_e = g\,|\,Z_e\,|_{f=f_0}$$

where

$$Z_e = \prod_{n=1}^{n_s} Z_n^{1/n_s}.$$

It can be shown that G_e is of the form

$$G_s = \frac{g}{2\pi f_0 C_e} F_e \tag{1}$$

where

C_e = equivalent capacitance per stage
F_e = equivalent gain factor per stage

and both C_e and F_e depend on the type of unit network. If the performance parameter P is defined as equivalent gain per stage times fractional half bandwidth, then

$$P = G_e\left(\frac{f-f_0}{f_0}\right) = \frac{gx}{2\pi f_0 C_e} \tag{2a}$$

where

$$x = F_e\left(\frac{f-f_0}{f_0}\right). \tag{2b}$$

Amplitude Distortion

The amplitude distortion associated with a unit network D_a may be defined as the ratio of the modulus of the output voltage at frequency f to that at carrier frequency f_0, expressed as an attenuation in decibels, and is given by

$$D_a = 20n_s[\log_{10}|\,Z_e\,|_{f=f_0} - \log_{10}|\,Z_e\,|\,]. \tag{3}$$

Phase Distortion

The phase distortion associated with a unit network D_p may be defined as the difference between the actual phase shift ϕ at frequency f and that which would obtain if the phase-shift frequency gradient were constant at the carrier frequency value, i.e.,

$$D_p = \phi - \phi_0 - (f-f_0)\left(\frac{d\phi}{df}\right)_{f=f_0}. \tag{4}$$

IV. Formulas for Phase and Amplitude Distortion

A. Single-Tuned Circuit

The transfer impedance Z_s for a parallel-loaded tuned circuit is given by

$$Z_s = \frac{1}{2\pi f_{rs} C_s\left[\frac{1}{Q_s} + j\left(\frac{f}{f_{rs}} - \frac{f_{rs}}{f}\right)\right]} \tag{5}$$

where

f_{rs} = resonant frequency
Q_s = circuit Q
C_s = capacitance of tuned circuit.

The derived phase-frequency characteristic shows a point of inflection, which is a point of skew symmetry, at a frequency slightly lower than f_{rs}. Assuming that the circuit is so tuned as to locate the carrier frequency f_0 at the point of phase symmetry, it can be shown that the phase distortion per stage in radians is given to a very close approximation by

$$D_{ps} = 2Q_s\left(\frac{f-f_0}{f_0}\right) - \text{arc tan}\left[2Q_s\left(\frac{f-f_0}{f_0}\right)\right] \tag{6a}$$

which may be expressed in the form

$$D_{ps} = \frac{\lambda}{J} - \text{arc tan}\left(\frac{\lambda}{J}\right) \tag{6b}$$

where

$$\lambda = K_1\left(\frac{f-f_0}{f_0}\right) \tag{6c}$$

and

$$J = K_1/2Q_s, \tag{6d}$$

and is a scale-adjusting factor used in Section IV*D* for the determination of the conditions for compensation. The curve of D_{ps} is skew symmetrical about $\lambda = 0$, i.e., $f = f_0$, and is positive for positive values of λ.

The amplitude distortion per stage D_{as} is then given approximately by

$$D_{as} = 10\log_{10}\left[1 + \left\{2Q_s\left(\frac{f-f_0}{f_0}\right)\right\}^2\right] \tag{7a}$$

which may be expressed in the form

$$D_{as} = 10\log_{10}\left[1 + \left(\frac{\lambda}{J}\right)^2\right]. \tag{7b}$$

Whereas D_{as} as given by (7) is symmetrical about $\lambda=0$, i.e., $f=f_0$, a rigorous analysis, while giving substantially the same bandwidth for the same distortion, requires the band to be displaced towards the higher frequencies. The approximate symmetrical equation will usually be sufficiently accurate for general design purposes, but corrections may be applied as a refinement if required. If for a particular value of distortion the symmetrical curve gives a fractional bandwidth of $2(f-f_0)/f_0$, and the true upper and lower frequencies as rigorously derived are f_u and f_l, respectively, then the true fractional bandwidth is given by

$$\frac{f_u - f_l}{f_0} = \frac{f_{rs}}{f_0}\left[\frac{2\,(f-f_0)}{f_0}\right] \tag{8}$$

and the deviation of its midpoint from the carrier frequency is given by

$$\frac{\{(f_u+f_l)/2\}-f_0}{f_0} = \frac{f_{rs}}{f_0}\left[1+\left(\frac{f-f_0}{f_0}\right)^2\right]^{1/2} - 1$$

$$\Omega\,\frac{f_{rs}-f_0}{f_0} + \frac{1}{2}\left(\frac{f-f_0}{f_0}\right)^2 \tag{9}$$

where f_{rs} is given by (29) of Table III and is an inverse function of Q_s.

B. Coupled-Tuned Circuits

It can be shown that the transfer impedance Z_c associated with a pair of coupled circuits, which are tuned to the same frequency f_{rc} and are of equal Q, can be expressed in the form

$$Z_c = AZ_{s1}Z_{s2} \tag{10}$$

where

$$A = \frac{-jk2\pi f_{rc}^2(C_1C_2)^{1/2}}{f(1-k^2)} \tag{10a}$$

$$Z_{s1} = \frac{1}{2\pi f_{r1}C_1\left\{\frac{1}{Q_1}+j\left(\frac{f}{f_{r1}}-\frac{f_{r1}}{f}\right)\right\}} \tag{10b}$$

$$Z_{s2} = \frac{1}{2\pi f_{r2}C_2\left\{\frac{1}{Q_2}+j\left(\frac{f}{f_{r2}}-\frac{f_{r2}}{f}\right)\right\}} \tag{10c}$$

$$f_{r1} = f_{rc}/(1+k)^{1/2} \tag{10d}$$

$$f_{r2} = f_{rc}/(1-k)^{1/2} \tag{10e}$$

$$Q_1 = Q_c/(1+k)^{1/2} \tag{10f}$$

$$Q_2 = Q_c/(1-k)^{1/2} \tag{10g}$$

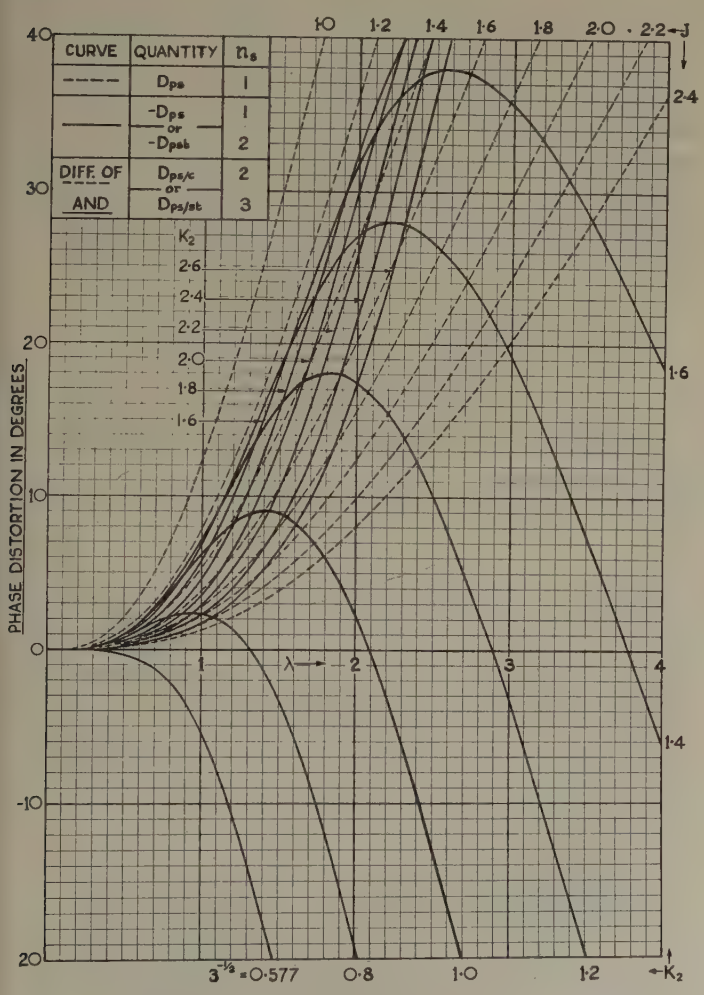


Fig. 1—Phase distortion for simple unit networks and derived compensating combinations.

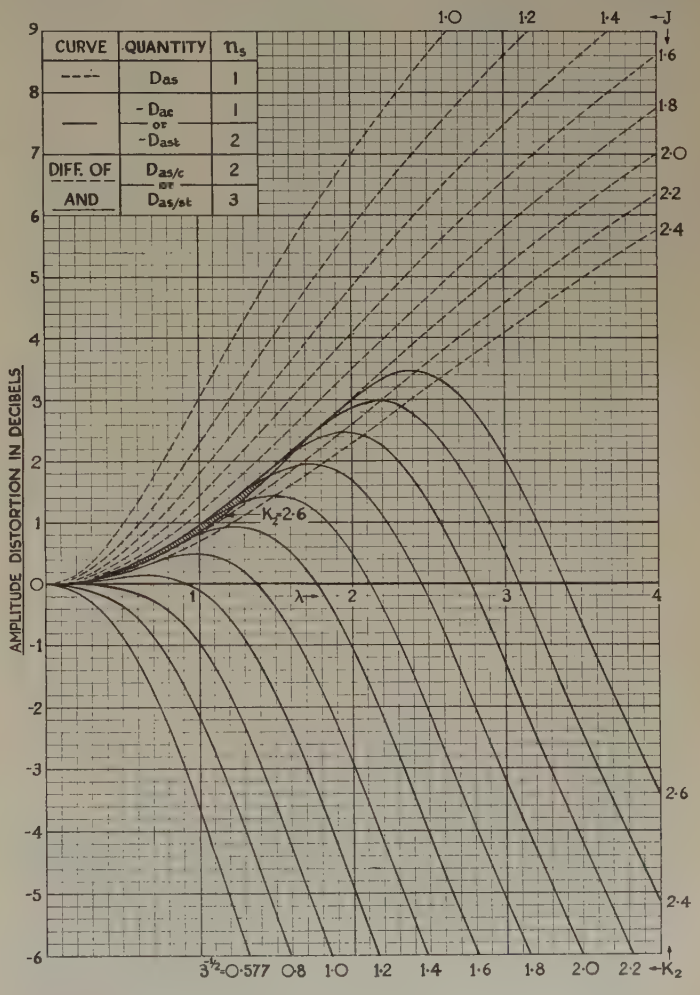


Fig. 2—Amplitude distortion for simple unit networks and derived compensating combinations.

Q_c = Q value of coupled circuits

k = coupling coefficient

C_1, C_2 = capacitances of coupled circuits.

Comparison with (5) indicates that Z_c is equivalent to A times the product of the impedances of two single resonant circuits, which have the same product of capacitance into shunt resistance and are tuned respectively to f_{r1} and f_{r2}.[4-5] Factor A is an inverse function of frequency and includes a phase shift of $-90°$.

The phase-frequency characteristic of coupled circuits shows a point of inflection which is a point of skew symmetry at a frequency slightly greater than the resonant frequency. If the resonant frequency is so adjusted that the point of phase symmetry is coincident with the carrier frequency f_0, derivation from (6) gives approximately for the phase distortion D_{pc} of coupled circuits

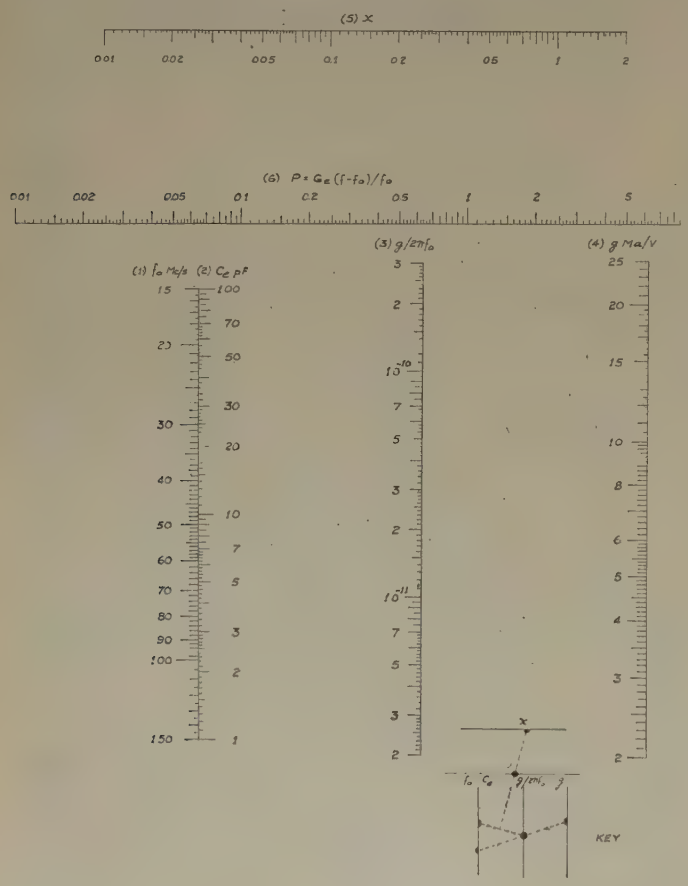


Fig. 3—Nomogram for performance parameter P. $P=G_c\left(\frac{f-f_0}{f_0}\right)=\frac{gx}{2\pi f_0 C_c}$. For C_c see Table II and Fig. 4. For x see Table II and Fig. 5.

$$D_{pc}=\frac{2\lambda}{1+K_2^2}-\arctan(\lambda+K_2)-\arctan(\lambda-K_2)$$

$$=\frac{2\lambda}{1+K_2^2}-\arctan\left(\frac{2\lambda}{1+K_2^2-\lambda^2}\right) \tag{11}$$

where

$$\lambda=K_1\left(\frac{f-f_0}{f_0}\right) \tag{11a}$$

$$K_1=Q_c[(1-k)^{-1/2}+(1+k)^{-1/2}]$$

$$\Omega\ 2Q_c \text{ for small values of } k \tag{11b}$$

$$K_2=Q_c[(1-k)^{-1/2}-(1+k)^{-1/2}]$$

$$\Omega\ Q_c k \text{ for small values of } k$$

$$\Omega\ k/k_c \text{ for large values of } Q_c \tag{11c}$$

k = coefficient of coupling

k_c = coefficient of critical coupling.

D_{pc} is skew symmetrical about $\lambda=0$, i.e., $f=f_0$, and is negative for positive values of λ over a certain range depending on the value of $K_2>1/\sqrt{3}$, beyond which it becomes positive. The position λ_p of the peaks is given by

$$\lambda_p=\pm(3K_2^2-1)^{1/2}. \tag{12}$$

A rigorous analysis gives curves for amplitude distortion which are symmetrical about f_0, f in the denominator of factor A of (10a) correcting for the inherent asymmetry associated with the equivalent single-tuned circuits. Thus, by adopting the approximate symmetrical equation (7) for single-tuned circuits and regarding f in factor A as constant, D_{ac} for coupled circuits can be shown to be given to a very close approximation by

$$D_{ac}=10\log_{10}[(1+K_2^2-\lambda^2)^2+4\lambda^2]-20\log_{10}[1+K_2^2]. \tag{13}$$

Critical coupling corresponds to $K_2=1$, above which the characteristic exhibits the familiar double hump, the peak values of which occur at λ_a given by

$$\lambda_a=\pm(K_2^2-1)^{1/2}. \tag{14}$$

Equations (11) and (13) show that phase distortion D_{pc} and amplitude distortion D_{ac} can each be represented completely in terms of the two parameters λ and K_2, and therefore by a single family of curves plotted against λ for different values of K_2 as illustrated by the full-line curves of Figs. 1 and 2. This is not possible, except for high values of Q, where the more usual parameters[1-3] $Q(f-f_0)/f_0$ and k/k_c are used.

C. Staggered-Tuned Circuits

For two stages of single resonant circuits tuned to frequencies f_{r1} and f_{r2} respectively, and having Q values Q_1 and Q_2 at these frequencies, the product of the transfer impedances is given by

[4] This equivalence has been pointed out by E. A. Guilleman' "Communication Networks," John Wiley and Sons, New York, N. Y., vol. 1, p. 324; 1946, for the case of identical coupled-tuned circuits. As shown above, the condition of identity is unnecessary, provided that the Q values are equal.

[5] The resonant frequencies f_{r1} and f_{r2} are equal respectively to the two natural resonant frequencies associated with coupled circuits of negligible damping. See G. W. O. Howe, "Analysis of frequency in oscillatory circuits," *Elec. World*, vol. 68, pp. 368–370; August 19, 1916. See also G. W. O. Howe, "Bandpass filters in radio receivers," *Experimental Wireless*, vol. 8, pp. 233–237; May, 1931.

$$Z_{s1} \times Z_{s2} = Z_{st}^2 \qquad (15)$$

where Z_{s1} and Z_{s2} are of the form of (10b) and (10c), respectively. If the circuits have the same product of capacitance into shunt resistance so that

$$\frac{Q_1}{f_{r1}} = \frac{Q_2}{f_{r2}} \qquad (16)$$

and are so tuned that the carrier frequency coincides with the point of skew symmetry of the resultant phase-shift characteristic, then the phase distortion D_{pst} for two stages of staggered circuits is given as for one stage of coupled-tuned circuits by (11) where

$$K_1 = Q_2 + Q_1 \qquad (17a)$$

$$K_2 = Q_2 - Q_1. \qquad (17b)$$

In this case, owing to the absence of a factor A with its correcting factor f, there will in practice be some asymmetry in the amplitude characteristic. For general design purposes, however, it is convenient to assume symmetry so that amplitude distortion D_{ast} for two stages of staggered circuits may be represented approximately by the same equation (13) as for a single stage of coupled-tuned circuits.

It is evident that the replacement of one stage of coupled-tuned circuits by two stages of staggered-tuned circuits offers the possibility of higher gain for the same distortion while at the same time affording greater facility of adjustment.

D. Compensating Combinations

The difference in sign of the phase and amplitude distortion associated with single- and coupled- or staggered-tuned circuits can be utilized to give a considerable measure of compensation over a range of λ, provided that certain relations obtain between the parameters J and K_2. Curves for phase and amplitude distortion are presented in Figs. 1 and 2 respectively in such a form as to reveal the appropriate relations. The broken line curves represent distortion arising from a single-tuned circuit, D_{ps} and D_{as}, as a function of λ for different values of J. The full line curves, on the other hand, show the mirror image of the distortion associated with a unit network of the coupled or staggered circuit type, i.e. $(-D_{pc})$ or $(-D_{pst})$ in Fig. 1 and $(-D_{ac})$ or $(-D_{ast})$

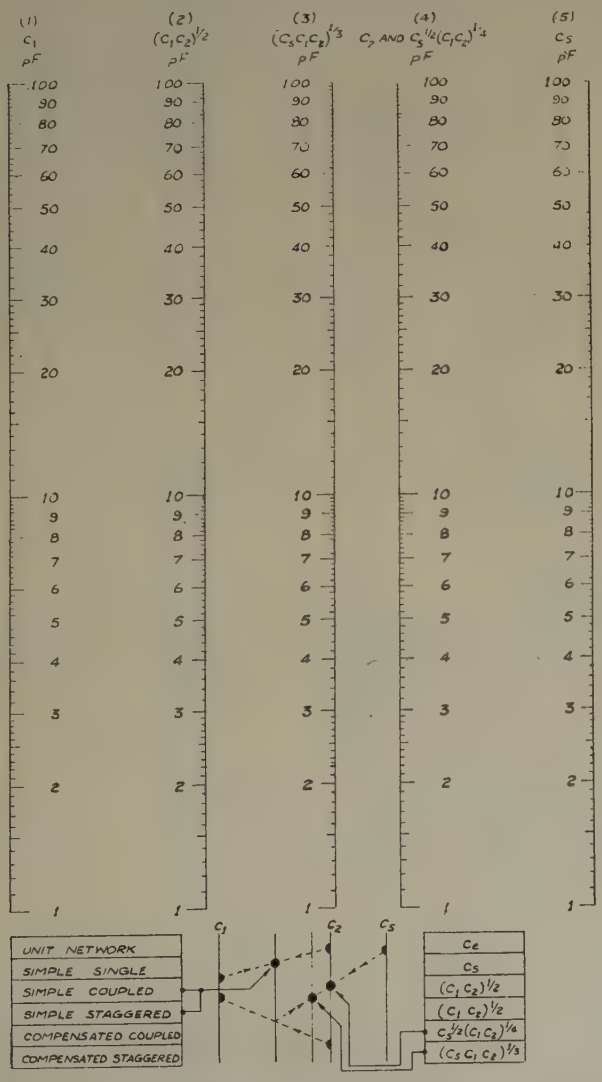


Fig. 4—Nomograms for equivalent capacitance C_e for simple and compensating unit networks.

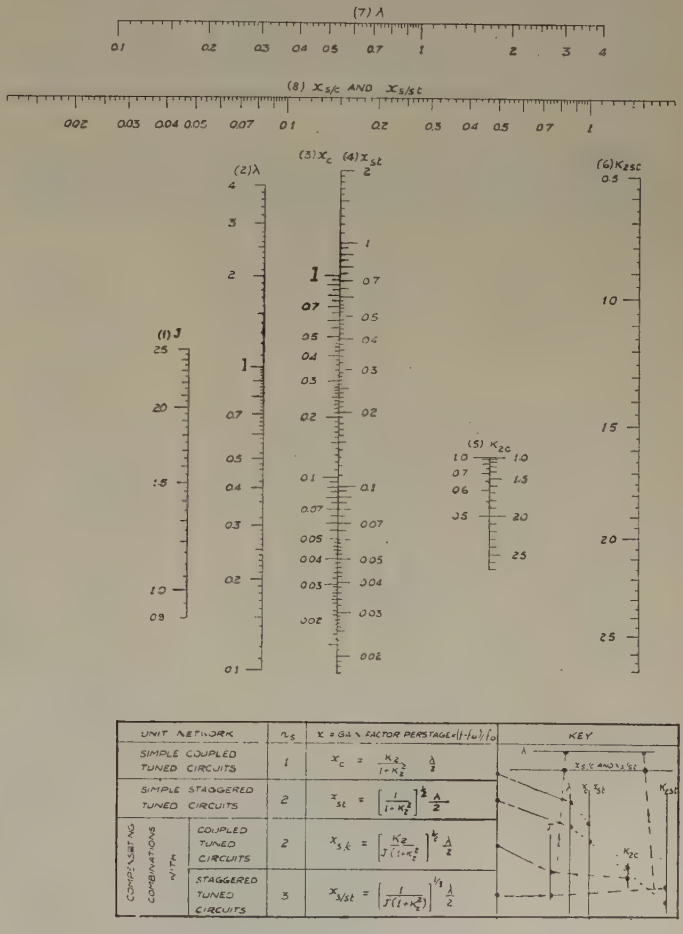


Fig. 5—Nomograms for conversion from λ to x for simple and compensating unit networks.

in Fig. 2, as a function of λ for different values of K_2.[6] Since both phase and amplitude distortion arising from a number of unit networks add algebraically, the difference between any J and any K_2 curve gives the resultant distortion $D_{ps/c}$, $D_{as/c}$, $D_{ps/st}$ or $D_{as/st}$ for the corresponding compensating unit network.

It is to be noted that equal increments of J correspond to equal increments of λ for the same distortion, which permits linear interpolation for intermediate values of J. Since $J=K_1/2Q_s$, $K_1\ \Omega 2Q_c$ for coupled circuits and $K_1=(Q_1+Q_2)$ for staggered circuits, J represents approximately the ratio of the Q of coupled circuits or the mean Q of staggered circuits to that for the single-tuned circuit.

It is apparent from Fig. 2 that maximum compensation for amplitude distortion requires a value of J of the order of 2, which may not necessarily represent the optimum value for compensation of phase distortion, and some compromise may be required. For special purpose where both phase and amplitude distortion are required to be very small, a better compromise may be possibly achieved by the use of more complicated compensating combinations involving three or more simple unit networks, e.g., one of the single-tuned circuit type and two of the coupled- or staggered-tuned circuit types. Mathematical treatment is difficult but design can conveniently be carried out by trial and error, using the curves of Figs. 1 and 2. It may be found convenient to use different equation parameters (K_1 and K_2) for unit networks of similar type; the values of D_p and D_a corresponding to a given frequency deviation must then be derived for different values of $\lambda=K_1(f=f_0)/f_0$ in the two cases.

[6] Intersection and close proximity preclude the separate delineation of the D_{ac} curves for $K_2=1.4$ to 2.4 at low values of λ. They all fall within the cross-hatched area and are of the same general form as the curve for $K_2=2.6$, which follows the lower boundary.

V. Evaluation of Performance Parameter P

To compare the merits of different circuit arrangements it is necessary to interpret λ in terms of performance parameter P, i.e., equivalent gain per stage at car-

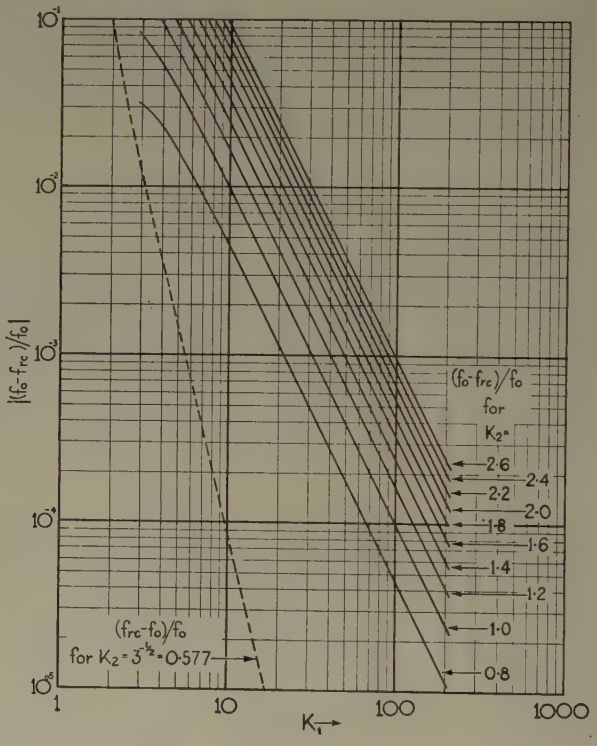


Fig. 7—Resonant frequency of coupled-tuned circuits in terms of equation parameters.

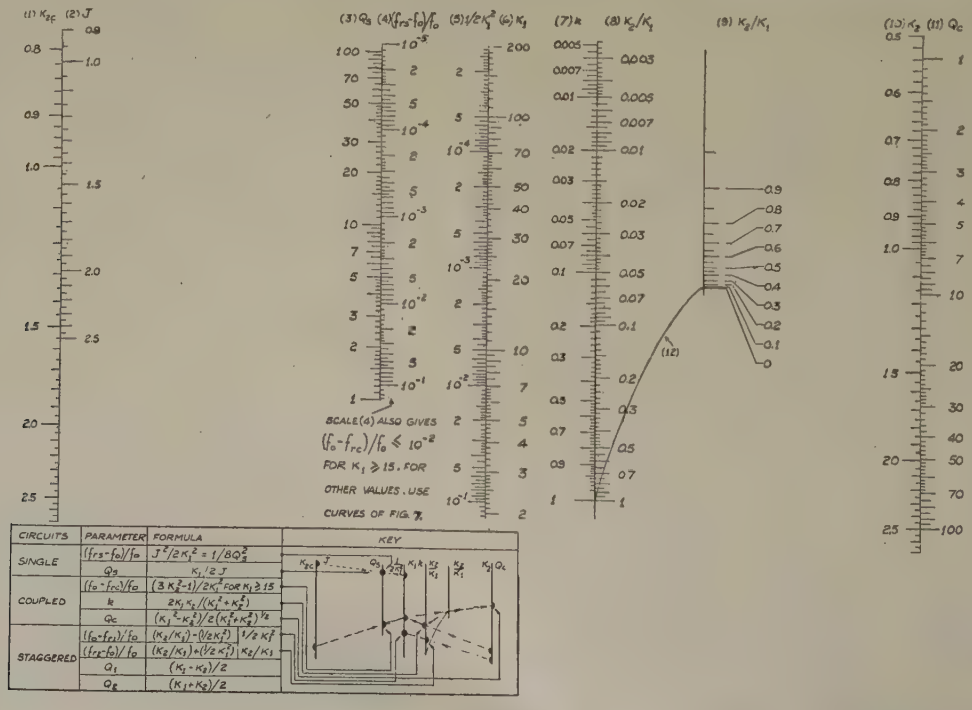


Fig. 6—Nomograms for conversion from equation to circuit parameters for single-, coupled-, and staggered-tuned circuits.

rier frequency times fractional semibandwidth, which is given by (2) and may be evaluated by the nomogram of Fig. 3, using a set-square index.[7]

This formula involves C_e, the equivalent capacitance per stage and x, the equivalent gain factor per stage times fractional half bandwidth. Both factors are given for specific unit networks by the equations of Table II and may be evaluated from the nomograms of Figs. 4 and 5 respectively. For more complicated combinations, C_e and x are given by the geometric mean of the values of C_e and x associated with the component stages.

[7] H. J. Allcock and J. R. Jones, "The Nomogram," Pitman, London, England, chap. 4; 1946.

VI. Conversion from Equation Parameters to Circuit Parameters

The required circuit parameters are resonant frequencies, Q values, and for coupled circuits, coefficient of coupling. They are given for the three basic unit networks by the conversion equations of Table III and may be evaluated from the nomograms of Fig. 6 and curves of Fig. 7.

Error in the tuning of the resonant circuits will give rise to asymmetry in the distortion characteristics of Figs. 1 and 2. A positive error Δf_r in the resonant frequency of single- or coupled-tuned circuits or in the mean resonant frequency of staggered-tuned circuits will cause a shift to the right by an amount $\Delta\lambda\Omega K_1\Delta f_r/f_0$.

TABLE II

Equations for Evaluation of Factors Involved in Performance Parameter for Various Unit Networks

Unit Network		Number of Stages n_s	Equation[1]		
			Factor	Expression	Number
Single-tuned circuit		1	C_e	C_e	(18)
			x_e	$\frac{\lambda}{2J}$ [2] $= \frac{\lambda}{2}$ for $J = 1$	(19) (19a)
Coupled-tuned circuits		1	C_e	$(C_1C_2)^{1/2}$	(20)
			x_c	$\frac{K_2}{1+K_2^2}\cdot\frac{\lambda}{2}$	(21)
Staggered-tuned circuits		2	C_e	$(C_1C_2)^{1/2}$	(22)
			x_{st}	$\frac{1}{(1+K_2^2)^{1/2}}\cdot\frac{\lambda}{2}$ [3]	(23)
Compensating combinations comprising	Single-tuned circuit, Coupled-tuned circuits	1 } 2 1 }	C_e	$C_s^{1/2}(C_1C_2)^{1/4}$	(24)
			$x_{s/c}$	$\left[\frac{K_2}{J(1+K_2^2)}\right]^{1/2}\cdot\frac{\lambda}{2}$ [4]	(25)
	Single-tuned circuit, Staggered-tuned circuits	1 } 3 2 }	C_e	$(C_sC_1C_2)^{1/3}$	(26)
			$x_{s/st}$	$\left[\frac{1}{J(1+K_2^2)}\right]^{1/3}\cdot\frac{\lambda}{2}$ [5]	(27)

[1] Equations (20), (22), (24), and (26) may be evaluated from Fig. 4 and (21), (23), (25), and (27) from Fig. 5.
[2] The gain factor included in x_s is strictly that at the resonant and not the carrier frequency, but the difference is negligible for practical purposes.
[3] This equation is correct to within 1 per cent for $K_1 \geqq 7$; for other values of K_1 there will be slight errors.
[4] This equation involves the limitations of footnote 2 above.
[5] This equation involves the limitations of footnotes 2 and 3 above.

VII. Computing Procedure Illustrated by Numerical Examples

The computing procedure for the design of intermediate-frequency amplifiers for minimum distortion, when the bandwidth and over-all gain are specified, is outlined in Table IV and illustrated by two numerical examples for compensating unit networks of the coupled and staggered circuit types respectively.

The alternative case, when the maximum distortion is specified and it is required to design for maximum gain times bandwidth, can equally well be treated by a revised order of steps.

VIII. Conclusions

To meet the desiderata of wide bandwidths and low phase distortion, parallel loading of resonant circuits used as coupling networks has been assumed, together with the requisite detuning to locate the point of phase symmetry at the carrier frequency.

Simple approximate equations are given for the distortion associated with a single-tuned circuit, and corrections, which may be applied as a refinement, are indicated. For a unit network comprising one stage of coupled-tuned circuits of equal Q or its distortion equivalent of two stages of staggered-tuned circuits, the adoption of novel parameters leads to relatively simple equations for phase and amplitude distortion, each of which may then be represented by a single family of curves. Such representation permits advantage to be taken of the difference in sign of the distortion associated with single- and coupled- or staggered-tuned circuits over a certain range of parameters, to design compensating combinations.

TABLE III

Equations for Conversion from Equation to Circuit Parameters for Various Coupling Networks

$$K_1 = \lambda \Big/ \left(\frac{f - f_0}{f_0}\right) \qquad (28)$$

Coupling Network	Circuit Parameter	Conversion Formula	
		Expression	Number
Single-tuned circuit	$\frac{f_{rs} - f_0}{f_0}$	$\left[2\left(1 - \frac{J^2}{K_1^2}\right)^{1/2} - 1\right]^{-1/2} - 1$ $\Omega\ \frac{J^2}{2K_1^2} = \frac{1}{8Q_s^3}$ for $\frac{f_{rs} - f_0}{f_0} \leqq 0.01$	(29)
	Q_s	$\frac{K_1}{2J}$	(30)
Coupled-tuned circuits	$\frac{f_0 - f_{rc}}{f_0}$	$1 - \frac{2Q_c}{K_1\left[\left(4 - \frac{1}{Q_c^2}\right)^{1/2} - 1\right]^{1/2}}$ $\Omega\ \frac{3K_2^2 - 1}{2K_1^2}$ for $K_1 \geqq 15$	(31) (31a)
	k	$\frac{2K_1K_2}{K_1^2 + K_2^2}$	(32)
	Q_c	$\frac{K_1^2 - K_2^2}{2(K_1^2 + K_2^2)^{1/2}}$	(33)
Staggered-single-tuned circuits	$\frac{f_0 - f_{r1}}{f_0}$	$\frac{K_2}{K_1} - \frac{1}{2K_1^2}$ for $K_1 > 4$	(34)
	$\frac{f_{r2} - f_0}{f_0}$	$\frac{K_2}{K_1} + \frac{1}{2K_1^2}$ for $K_1 > 4$	(35)
	Ω_1	$\frac{K_1 - K_2}{2}$	(36)
	Q_2	$\frac{K_1 + K_2}{2}$	(37)

Note—Equations (29), (30), (31a), and (32) through (35) may be evaluated from the nomograms of Fig. 6. For $K_1 < 15$ and $(f_0 - f_{rc})/f_0 > 0.01$ use should be made of (31) which may be evaluated from the curves of Fig. 7.

Sets of nomograms and curves provide for the evaluation of the performance parameter (equivalent gain per stage times fractional semibandwidth) in terms of the tube mutual conductance, equivalent shunt capacitance, carrier frequency, and equation parameters, and for the conversion from equation to circuit parameters (resonant frequencies, Q values, coupling coefficient) for the various unit networks. The procedure for using the graphical data is indicated and illustrated by two numerical examples.

IX. Acknowledgments

The author wishes to thank Brigadier J. B. Hickman, Managing Director, British Telecommunications Research Ltd., T. Walmsley, former Director of Research under whose directorship the work was carried out, and F. O. Morrell, present Director of Research, for permission to publish this paper. The author is also indebted to D. A. Bell, for helpful advice during the course of the work, and to those colleagues who assisted in the preparation of the manuscript.

TABLE IV

Computation of Distortion and Circuit Parameters for Typical Compensated Unit Networks to Give Specified Over-all Gain and Bandwidth

Specified over-all gain = 10^5

Specified bandwidth = ± 1 Mc $\left.\frac{f-f_0}{f_0}=\frac{1}{30}\right.$

Specified carrier frequency = 30 Mc

Assumed g = 5 mA/V $\left.\frac{g}{2\pi f_0}=2.65\times 10^{-11}\right.$.

Step	Quantity		Equation	Fig.	Compensating Combinations	
1	Unit network: Coupling circuit / Number of stages n_s				Single 1 + Coupled 1	Single 1 + Staggered 2
	Associated capacitances	C_s pF C_1 pF C_2 pF			15 7.5 12.5	15 13.5 16.5
2	Equivalent capacitance C_e pF		(24) (26)	4 4	12	 14.95
3	Number of unit networks n_u Total number of stages $n_u \cdot n_s$				2 4	1 3
4	Equivalent gain per stage G_s				$10^{5/4}$	$10^{5/3}$
5	$P=G_s(f-f_0)/f_0$				0.5925	0.718
6	x		(2a)	3	0.265	0.40
7	Selected values of	J K_2		1, 2	1.4 1.6	1.25 1.20
8	λ		(25) (27)	5 5	0.94	 1.16
9	D_p (per unit network) degrees D_a (per unit network) db n_uD_p degrees n_uD_a db			1 2	−0.2 0.85 −0.4 1.7	0.2 3.1 0.2 3.1
10	K_1		(28)		28.20	34.8
11	Single-tuned circuit	$(f_{rs}-f_0)/f_0$ Q_s	(29) (30)	6 6	1.22×10^{-3} 10.1	6.5×10^{-4} 13.9
	Coupled-tuned circuit	$(f_0-f_{rc})/f_0$ k Q_c	(31a) (32) (33)	6 6 6	4.2×10^{-3} 0.113 14.1	
	Staggered-tuned circuit	K_2/K_1 $1/2K_1^2$		6		3.42×10^{-2} 4.1×10^{-4}
		$(f_0-f_{r1})/f_0$ $(f_{r2}-f_0)/f_0$ Q_1 Q_2	(34) (35) (36) (37)			3.38×10^{-2} 3.46×10^{-2} 16.8 18.0

Marginal Checking as an Aid to Computer Reliability*

NORMAN H. TAYLOR†, SENIOR MEMBER, IRE

Summary—**Deteriorating components, particularly crystals and vacuum tubes, cause reduction of safety margins and are a principal source of error in digital computing and pulse communication.**

Marginal checking varies voltages in logical circuit groups, inducing inferior parts to cause failure, while a test program or pulse transmission detects and localizes potential failure. In a digital computer, this can be automatically accomplished with the computer itself acting as the detector.

In one trial on a 400-tube prototype system the application of this type of preventive maintenance for half an hour per day improved reliability 50 to 1. Results of preliminary tests on a full computer are discussed.

I. Introduction

ELECTRONIC digital computers will be used to solve real-time problems and must be reliable. For example, when the modern computer becomes the nerve center of an all-weather air traffic control system, the plane pilot must know the system is operating, and will continue to operate, without error. Such reliability can be guaranteed only by detecting imminent failures and preventing their occurrence.

In order to obtain "computer reliability," a much higher degree of performance is required than in ordinary means of communication. The basic difference is the high concentration of information used in a computer compared with the concentration of information in speech, television, or radar. Interruptions in circuits of the latter type can occur at frequent intervals, with little loss of intelligence. An occasional intermittent tube does not void the sense from a radio, ignition noise does not completely void television, nor does an arcing magnetron nullify the plot on a radar screen.

This criterion is not good enough in computer applications. The usual method of transmitting intelligence in a computer is to supply high-frequency pulses to particular circuits at specified times. A single pulse occurring at the wrong time can invalidate the usefulness of the whole effort. This single-error limitation is due to the presence of a memory in a computer. Memory remembers the errors as well as the information to be processed, and once an error becomes imbedded in the memory it can be propagated into all subsequent calculation.

The necessary reliability can be approached by combining good design with the best available components, and utilizing marginal checking as an additional aid.

Marginal checking differs from ordinary checking by not only answering the question, "Are all circuits functioning?" but also, "How much *longer* will the circuits function?" Good equipment starts with wide safety margins, but age and wear reduce these safety margins, leading to eventual failure. Marginal checking assures adequate safety by testing the system frequently enough so that only slight deterioration can occur between tests.

* Decimal classification: 621.375.2. Original manuscript received by the Institute, April 6, 1950; revised manuscript received, July 28, 1950.

† Massachusetts Institute of Technology, Cambridge, Mass.

II. The Marginal Checking System

A. Magnitude of the Problem

Most of the large-scale digital machines under development utilize many thousands of vacuum tubes, crystals, resistors, condensers, and coils. The vacuum tube is the least reliable component of this group, and the crystal rectifier, though better than the tube, is still a weak link in the chain of reliability. Failures in the resistors, condensers, and coils are not frequent, and these elements do not threaten computer reliability to such an extent.

What may be expected of a system using present-day vacuum tubes and crystals? A few assumptions will serve to indicate the problem. If a typical computer has 5,000 cathodes and 10,000 crystals, suppose the tubes will last on an average of 5,000 hours, and the crystals, 10,000 hours. Every 30 minutes one of these aging components may cause a failure. Furthermore, some of these failures will not be steady but will cause marginal operation and thus be very difficult to locate. In a typical 8-hour day this may cause 16 shutdowns. Even if a trouble-location technique is well developed, so that the period of shutdown is short, the efficiency of the machine will be very low. One might ask if a periodic replacement program could be followed which would eliminate many of these component failures. Unfortunately, early failure in groups of new tubes is quite high, so that wholesale replacement on simply a time basis would increase the failure rate.

B. Features of Marginal Checking

The preventive maintenance techniques called marginal checking use performance margins to establish life expectancy of components, so that those with low margins can be removed during a testing period.

Three features of this marginal checking scheme make it very practical for use in large electronic systems:

(1) The checking system can detect imminent failures before they become real failures and cause computational error.

(2) This detection can isolate the failing component to a specific tube, crystal, or resistor.

(3) Such isolation can be so rapid that it consumes only a small percentage of total machine time.

1. Conversion to Real Failures: The conversion of imminent failures to real failures during test periods is the important key in this marginal checking system. Such checking is possible in computers and also in many other pulse systems due to the on-off nature of the circuitry used.

In a computer, information passes from one place to another as the presence or absence of a pulse on a transmission line. It is not necessary that the pulse be of any particular amplitude to get this information to its destination but only that the pulse be large enough to affect the detector. If the presence of a pulse means a 1 and the absence a 0, then a pulse which is too small to affect the detector has the same effect as no pulse at all and so a 0 is recorded.

a. A Simple Computer Channel

Fig. 1 gives a typical basic block diagram often encountered in pulse systems. Gate tube *A*, when open, allows pulses to pass along a channel to a flip-flop. If the pulses are large enough and the flip-flop in proper condition, each pulse will cause a reversal of the flip-flop from a 1 to 0 or vice versa.

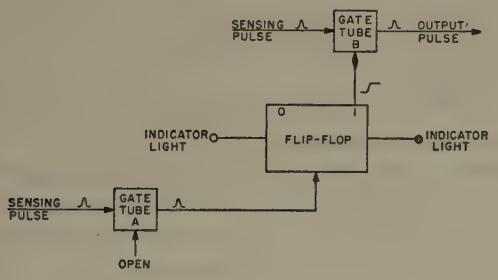


Fig. 1—A typical computer channel.

Two sorts of trouble may develop. First, the gate tube may deteriorate and cause the pulse amplitude to be reduced to a point where the flip-flop will not switch or, second, the flip-flop may refuse to switch because one of its components has deteriorated.

b. Checking the Gate Circuit

The margin of performance in the gate tube (*A*) can be checked by lowering the voltage on the screen of the tube by inserting a negative voltage in series with the screen lead as shown in Fig. 2 (a schematic for gate tube circuit). The pulses emerging from the tube will be lower than they were before the deviation.

If both the flip-flop and gate as shown in Fig. 1 have adequate margins then this marginal checking of the gate circuit will make no difference. This can be detected by another gate tube (*B*) which opens and closes according to the action of the flip-flop. If a sensing pulse is applied to gate tube *B* in Fig. 1, it will pass through to indicate that the flip-flop has switched and opened the channel. In the diagram shown this should occur for every other pulse passing through gate tube *A*.

A low margin in gate tube *A* will interrupt this sequence and no check pulse will emerge from gate tube

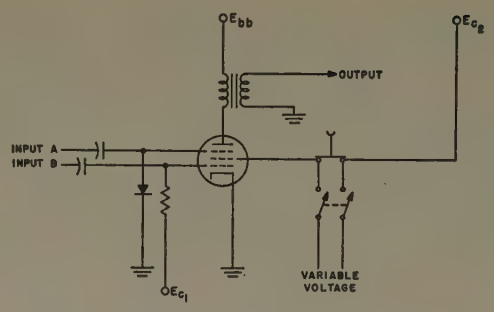


Fig. 2—Marginal checking of gate circuit.

B. From such a test it can be determined whether or not the gate circuit is nearing an unsafe condition. The circuit shown in Fig. 2 has a nominal screen voltage of 90 volts. A typical margin would be minus 20 volts from this value.

c. Checking the Flip-Flop

This first check assumed that the flip-flop was performing normally and acting as a detector for the arrival of pulses. To check this assumption the following test can be made on the flip-flop circuit.

Fig. 3 is a simplified schematic of a flip-flop. One tube must have the ability, when conducting, to hold the other tube in a nonconducting state. The circuit is completely symmetrical. Tube deterioration shows up as a reduction in plate current in one tube with a consequent reduction of bias available to the opposite tube. The large cathode resistor allows considerable aging before the condition becomes intolerable but eventually tube deterioration will become so extreme that instability will occur and the flip-flop will favor one side. Then, whenever it is ordered to change sides by an incoming pulse the circuit will either fail to switch or fail to hold its new position after switching takes place.

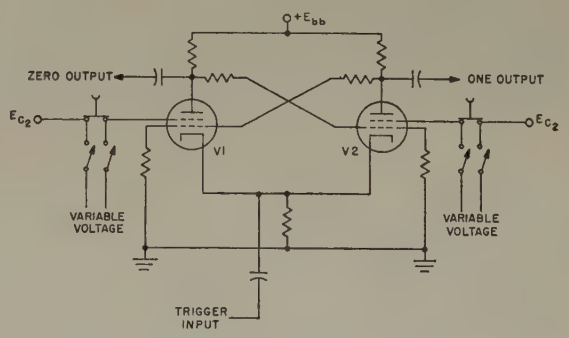


Fig. 3—Marginal checking of flip-flop circuit.

This unfavorable condition can be detected before it leads to failure by feeding the two screen circuits of the flip-flop separately, as shown in Fig. 3, and selectively raising the screen voltage of the normally off tube about 30 volts (nominal value 120 volts). Raising its screen voltage also raises its number 1 grid cutoff voltage. The normally on tube must have a safe margin of plate current available if it is able to hold the tube being checked

off under these extreme conditions. If the on tube is weak it will fail to hold off the opposite tube and a spurious switching operation will result. The detection of this condition can be automatic by using the sensing pulses and gate circuits shown in Fig. 1.

d. Testing Crystals in a Clamp Circuit

A third type of conversion which will pick up aging crystals is of considerable interest. Fig. 4 shows a clamping circuit which couples the plate of a flip-flop to a gate tube. Proper operation of this circuit depends on the back resistance of the crystal staying at a high value so that proper clamping action will be available during the period between the voltage pedestals used for clamping. If the crystal deteriorates, the voltage at the grid of the gate circuit will appear as shown at the right of the diagram. Serious deterioration will result in the opening of the gate circuit when it should be closed.

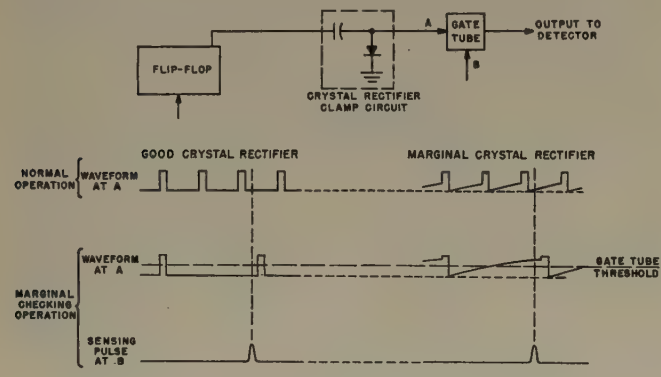


Fig. 4—Marginal checking of clamp crystal rectifiers.

To convert this imminent failure to a real one, a change in the timing of the clamping period is used. A good crystal will operate when a much longer period is allowed, but a deteriorating unit will not hold the bias that long and a failure will result. Values of 16 microseconds and 64 microseconds have been used effectively in this circuit. If a sensing pulse to the gate tube under control of this clamp circuit is inserted near the end of this longer wait period it will be rejected by a good crystal and passed by a deteriorating one. This scheme can then be automatized.

2. Localizing Failures: Once an imminent failure has been converted to a real failure by any one of the methods noted above, the problem of detecting the fault and localizing it to a particular source can be very time-consuming if it is not approached in an orderly manner. Fault isolation can be solved if the computer is divided for marginal checking into small logical sections. To simplify the trouble-location scheme, sections should be chosen so that at a given time only one fault can exist.

The logical design of a computer separates it into many channels, all starting at the pulse source and dispersing throughout the system to a destination.

Fig. 5 shows two of these typical channels separated into four sections. The vertical lines indicate how these channels may be broken for purposes of marginal checking and isolation of faults. In each case a pulse starts from the distributor along its channel and arrives at its destination with enough energy to change the condition of a flip-flop circuit in the destination section. If

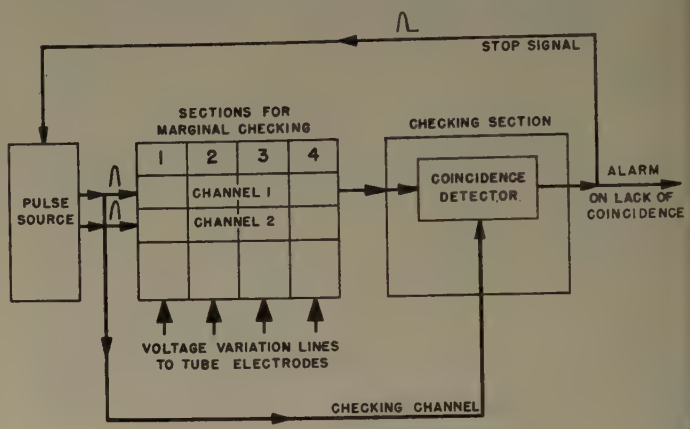


Fig. 5—Computer marginal checking.

each section is subjected to voltage variation and the sequence still functions, the channel can be said to have adequate margins.

The addition of a checking section to these channels allows the checking routine to be carried out automatically by the computer. An error-sensing pulse checks that the information arriving at the checking section via the channel under test is the same as that arriving by a separate checking channel. If the two pieces of information disagree, an alarm is sounded and immediately the pulse distributor is stopped.

Knowing the stopping point of the distributor, the channel at fault is isolated. In addition, knowledge of the section under voltage variation isolates the tube in the channel. The operator can usually find such troubles in a few minutes during such a test routine.

These channels are not used simultaneously but in a time sequence so tubes of the same type, but in different channels, may be grouped in the same section for voltage variation and no loss in isolation results.

3. Automatic Marginal Checking: The whole sequence of sending pulses through each of the channels has been automatized in the Whirlwind Computer system sponsored by the Office of Naval Research, at the Massachusetts Institute of Technology.[1] Some 200 sections are used. The computer program sends the pulses through each of the channels in a fraction of a second. Successive sections are selected by telephone switching apparatus and subjected to voltage variation at 5-second intervals. In this way the whole system can be completely checked in about 15 minutes.

[1] The Whirlwind Computer is an electronic digital machine capable of performing at very high speed; i.e., 13,000 multiplications per second.

At present it appears that establishment of adequate margins once each day will be an excellent guarantee that the next 24-hour period will be completely free from error.

It is evident that the basic principles of marginal checking discussed in this paper are simple; but the system must be carefully designed to reap advantages of the checking in an economical way. Too many checking circuits complicate the equipment; not enough will fail to give unique indications and will not isolate defective components.

III. Conclusion

The most significant information about marginal checking is its performance record. Over a period of eight months, a 5-binary-digit prototype arithmetic element at MIT has been running a test problem over and over 24 hours a day. This test system contains about 400 vacuum tubes and 1,000 crystals, and marginal checking is done manually for a period of $\frac{1}{2}$ hour a day and deteriorating components are removed. This equipment has made several runs of three weeks without computational error which represents 2.5×10^{10} correct solutions of the problem, and about 10^{13} correct flip-flop reversals in 25 flip-flop circuits. The average run without error has been eleven days, which represents approximately a 50-to-1 improvement in the results obtained before marginal checking was installed. A run of forty-five days without error was made in early 1950. During this forty-five-day period, 12 tubes, 7 crystals, and 4 resistors were located during marginal checking periods and replaced because of low margins.

When one begins to work with larger systems, there is reason to believe that, with marginal checking, errors will not increase in proportion to the extra equipment involved. A high percentage of the remaining errors are caused by power failure, lightning, and external disturbances independent of the number of vacuum tubes in the system.

A measure of the success of marginal checking in improving the performance of the Whirlwind Computer is shown in Table I.

At present, 3,900 tubes and 11,000 crystals have been running for about 3,300 hours. 32 registers of test storage, made up of toggle switches and flip-flops, allow the solution of several problems which thoroughly test the computer.

TABLE I

Tube and Crystal Failures*

	Tubes	Crystals
Number in use	3,900	11,000
Total failures	187	272
Obvious faults	76	7
Deterioration of operating characteristics	111	265
Failures located by marginal checking	109	223

* Note—Majority of tubes and crystals were in operation for 3,300 hours.

During these installation tests, 187 tubes have been removed, 109 of which have been located by marginal-checking techniques. The majority of tube failures with deteriorating characteristics have been due to the formation of an apparent resistance on the cathode sleeve or in the cathode coating. This defect has been called interface resistance.

Obvious tube faults have been due to gas, broken pins, internal short circuits, and open welds. Many of these have been located by the built-in checking system of the computer without the aid of marginal checking.

Of the 272 crystal failures, 223 were located by the marginal-checking technique. The most serious fault has been a drifting of back resistance to a lower value by a factor of 2 to 10 with the continued application of voltage. The cause of this is not well understood but 1 to 10 per cent of new crystals exhibit this tendency after voltage has been applied for a period of 30 to 60 seconds. A few obvious faults have been due to completely open or short-circuited crystals.

About a dozen tubes and a few crystals have been intermittent. The on-off intermittent is the most difficult fault to locate in electronic circuits. Marginal checking does not aid in isolating this type of failure and this represents one limitation in the system. Complete failure such as filament burnout also cannot be predicted. However, in 3,300 hours of operation, only two tubes have exhibited such failure.

Some of the by-products of marginal checking have proved invaluable in testing the Whirlwind system. Many low performance margins have been found which were due to design weaknesses and not to deteriorating components.

Refinements have been made in the design to reduce noise level and improve timing of pulse sequences and frequency response. These improvements have all been possible earlier in the program than usual, due in a large measure to marginal checking.

Bibliography

The following references have been published by Project Whirlwind, Servomechanisms Laboratory, Massachusetts Institute of Technology, under Contract N50R160 for the Office of Naval Research. They are available at the Library of Congress, Naval Research Section, upon request.

1. D. R. Brown, M. H. Hayes, and I. J. O'Brien, "Vacuum Tube Life," Project Whirlwind Report R-139, Cambridge, Mass., 1948.
2. G. Cooper, "A Method of Test Checking an Electronic Digital Computer," Project Whirlwind Report R-177, Cambridge, Mass., 1950.
3. R. R. Everett and F. E. Swain, "Whirlwind I Computer Block Diagrams," Project Whirlwind Report R-127, Cambridge, Mass., 1947.
4. H. B. Frost, "Vacuum Tube Life," Project Whirlwind Report R-179, Cambridge, Mass., 1950.
5. G. G. Hoberg and E. I. Blumenthal, "A Trouble-Location Scheme for a Digital Electronic Computer," Project Whirlwind Report R-163, Cambridge, Mass., 1948.
6. G. C. Sumner, "Trouble Location in a Large Scale Digital Computer," Project Whirlwind Report R-162, Cambridge, Mass., 1948.

A Digital Electronic Correlator*

HENRY E. SINGLETON†, SENIOR MEMBER, IRE

Summary—**The relation between correlation functions and the general theory of communication is presented, and this relation leads to a technique for electronic computation of correlation functions and to the design of a machine for carrying out the computation. Because of the requirements of great accuracy and long storage, the machine makes use of binary digital techniques for storage, multiplication, and integration. Descriptions of the more unusual circuits in the machine are given, and circuit diagrams are included. A number of experimental results obtained by the machine are presented.**

THE APPLICATION of statistical methods to communication problems is still only a few years old, but already the power of the statistical approach is becoming generally appreciated.[1–5] An adequate body of statistical data is not yet available, however, and this lack prevents the full strength of the statistical technique from being brought to bear on a large number of communications problems. The branch of statistical theory which is applicable here, and which, indeed, must be considerably extended if it is to be of greatest use, is the theory of random processes. The theory of random processes enters because communication equipment must operate for an ensemble of possible signals, none of which can be specified in advance, but which instead are characterized by a set of probability distribution functions. The fundamental statistical parameters which are required for the solution of general communication problems are accordingly the set of functions which characterize the ensemble, namely, the probability distributions

$$P_n(y_1, t_1; y_2, t_2; \cdots; y_n, t_n), \quad n = 1, 2, \cdots$$

where $P_n dy_1 dy_2 \cdots dy_n$ is the probability that a member of the ensemble has values in the ranges (y_1, y_1+dy_1), (y_2, y_2+dy_2), $\cdots$, (y_n, y_n+dy_n) at times $t_1, t_2, \cdots, t_n$. Since P_i can be found from P_j for $j>i$, it follows that the P_n describe the process in successively greater detail as n increases.[6] In applications of the theory it is usual to assume that the probability distributions are invariant under a shift of the origin of time, i.e., that the process is stationary.

Although a knowledge of all the probability distributions P_n is required in order to treat more general communication problems, many problems can be handled through the use of the second probability distribution $P_2(y_1, t_1; y_2, t_2)$. Since for stationary ensembles the distribution P_2 depends not on the absolute values of t_1 and t_2 but on the difference t_2-t_1, it is convenient to abbreviate $P_2(y_1, t_1, y_2, t_2)$ as $P(y_1, y_2; \tau)$ where $\tau=t_2-t_1$. The experimental evaluation of $P(y_1, y_2; \tau)$ for even a single stationary ensemble is a lengthy task,[7] because it requires the evaluation of P for each point in the three-dimensional space y_1, y_2, τ. It is therefore fortunate and of considerable engineering interest that a certain class of communication problems[8] can be treated in terms of the moment of the distribution P

$$M(\tau) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} y_1 y_2 P(y_1, y_2; \tau) dy_1 dy_2. \tag{1}$$

The three-dimensional probability distribution undergoes a smoothing due to the process of integration, and the result is a one-dimensional rather than a three-dimensional function. Furthermore, the moment $M(\tau)$, which may be regarded as the average value of the product y_1y_2 (for a specified τ), can be evaluated without recourse to the probability distribution P. In fact, if $f(t)$ is a member of the ensemble, the average of products of pairs of values of $f(t)$ which are separated by time τ is the correlation function

$$\phi(\tau) = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} f(t)f(t+\tau)dt. \tag{2}$$

For a stationary process it follows from the ergodic theorem that $M(\tau)=\phi(\tau)$.

Theory of Computation

Since according to the above results only one member $f(t)$ of the ensemble is required to compute $\phi(\tau)$, a convenient approximate method of evaluating $\phi(\tau)$ experimentally is to average a large number of products of pairs of samples of $f(t)$

$$\phi(\tau) = \frac{1}{N}\sum_{1}^{N} a_n b_n(\tau), \tag{3}$$

* Decimal classification: 621.375.2. Original manuscript received by the Institute, March 21, 1950; revised manuscript received, July 11, 1950. Presented, 1950 National IRE Convention, March 8, 1950, New York, N. Y. This work has been supported in part by the United States Signal Corps, the Air Materiel Command, and the Office of Naval Research.

† Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Mass.

[1] N. Wiener, "The Extrapolation, Interpolation, and Smoothing of Stationary Time Series with Engineering Applications," John Wiley and Sons, Inc., New York, N. Y.; 1949.

[2] Y. W. Lee, Class Notes, Massachusetts Institute of Technology Course 6.563; 1948.

[3] N. Wiener, "Cybernetics," John Wiley and Sons, Inc., New York, N. Y.; 1948.

[4] C. E. Shannon, "A mathematical theory of communication," *Bell Sys. Tech. Jour.*, vol. 27, pp. 379–424, and pp. 623–657; July and October, 1948.

[5] S. O. Rice, "A mathematical analysis of random noise," *Bell Sys. Tech. Jour.*, vols. 23, 24, pp. 282–333 and pp. 46–156; July, 1944, and January, 1945.

[6] H. M. James, N. B. Nichols, and R. S. Phillips, "Theory of Servomechanism," MIT Rad. Lab. Series 25, McGraw-Hill Book Co., New York, N. Y.; 1947.

[7] W. B. Davenport, Jr., "A study of speech probability distributions," MIT Doctor of Science Thesis in Electrical Engineering; June, 1950.

[8] Notably the design of optimum linear systems, footnote references 1 and 2.

where N is a large number and a_n and b_n are samples of $f(t)$ which are separated by the interval τ.

Physically, the above discussion means that the computation may proceed as follows: a sample a_1 of the input time series is obtained and stored; after a time τ has elapsed, a sample b_1 is taken and stored; the two samples a_1 and b_1 are multiplied together; the product is stored, and the samples a_1 and b_1 are discarded. The sampling and multiplying process is carried out repetitively, and each time a product is obtained it is added to the cumulative sum of the products previously obtained. After N such products have been obtained, the sum is recorded and the device storing the products is reset to zero. The sum recorded represents the value of $N\phi(\tau)$ for the value of τ under consideration. Proceeding in this way, as many points on the correlation function may be obtained as desired. The procedure just described is used in the present machine. Although an average might be obtained in a shorter period of time by delaying the entire wave form, such a procedure would require the use of more complex equipment.

General Design Specifications

An earlier experimental correlator[9] at the Research Laboratory of Electronics, Massachusetts Institute of Technology, demonstrated the feasibility of high-speed electronic computation of correlation functions. Results on this earlier correlator pointed out the need for great accuracy in the computing circuits and in the specification of the delay τ, as well as a need for a very large range of possible values of τ. Although the preliminary machine served an exceedingly useful purpose, it was limited in the range of delay available, and hence unable to handle many of the problems susceptible to treatment by correlation functions. The present research was initiated in order to provide the laboratory with a highly flexible, general-purpose correlator; one which would meet the requirements of the numerous applications which had been proposed, and which would take advantage, in its design, of experience gained on the first correlator. The following general design specifications for the present machine were arrived at:

1. Wide-band input circuits (dc to 12 Mc/sec).
2. Wide range of delays (0 sec to 0.1 sec).
3. Minimum increments in τ to be less than 0.1 μsec.
4. Value of τ to be known to within 0.01 μsec.
5. Machine to be completely automatic.
6. Accuracy and long term stability to be as good as possible.

The requirement for great accuracy and stability, and especially for very long storage, strongly indicated the use of digital techniques. The binary system is therefore used for storing, multiplying, and integrating. By this means, possible sources of error are limited to the sampling circuits and to the circuits for translating the samples into binary numbers. Errors from these sources are first minimized by careful selection and design of the circuits used. Remaining errors are further reduced by a special feedback drift-compensating circuit. Descriptions of the circuit techniques used are given below, and together with the general description of the machine, form the body of the paper.

[9] T. P. Cheatham, Jr., "The experimental evaluation of correlation functions and their use in the statistical theory of communications," MIT Doctor of Science Thesis in Electrical Engineering; 1949.

General Description

A functional block diagram of the correlator is shown in Fig. 1. This is a straightforward translation of (3) into functional components. In order to avoid using a separate number generator for each of the two channels, a selector gate is used to route the A and B box cars

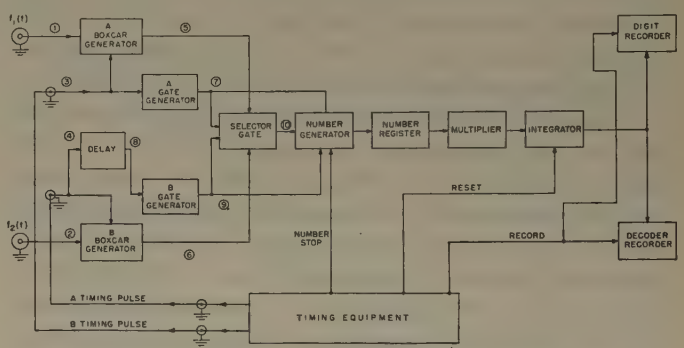


Fig. 1—Functional block diagram of correlator.

(or samples) successively to a single number generator If the inputs $f_1(t)$ and $f_2(t)$ are different, their cross correlation is obtained. If an autocorrelation function is required, the two inputs are connected together. The box-car generators are so called because their outputs consist of wide flat-topped pulses developed from the original narrow samples. Typical wave forms at the numbered points on Fig. 1 are shown in Fig. 2. The value of τ is controlled by fixing the time interval between pulses 3 and 4. Operation of the computer is as follows:

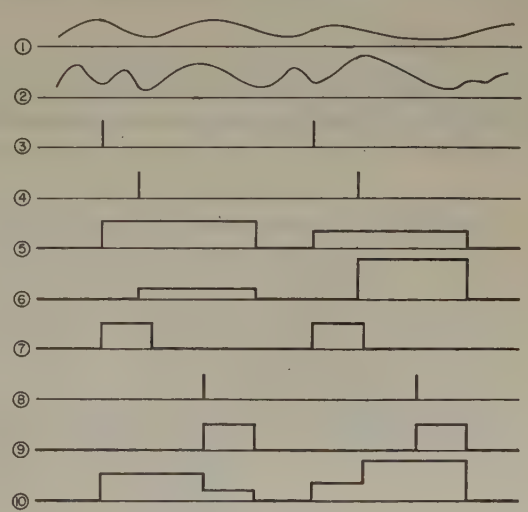


Fig. 2—Wave forms at numbered points of Fig. 1.

Box cars 5 and 6 are obtained from signals 1 and 2 at the time of occurrence of timing pulses 3 and 4. The selector gate normally passes the larger of the two box cars to the number generator, except during occurrence of gate 7 when box car 5 is passed, and during occurrence of gate 9 when box car 6 is passed. Gates 7 and 9 are also fed to the number generator, and during their occurrence the output of the selector gate is coded into binary form. The purpose of delaying pulse 4 to produce pulse 8 is to insure that gates 7 and 9 do not overlap for small or zero values of τ. Thus the number generator has time to code the first box car, gate the resulting binary digits into storage in the number register, and reset itself before it receives the signal (gate 9) to code the second box car. After the A and B numbers are stored in the number register, they are multiplied together in the multiplier and added to the previously accumulated products in the integrator. When a predetermined number of products (of the order of 10^5) has been accumulated, a number stop gating pulse of approximately four seconds duration goes out on the number stop line from the timing equipment to the number generator, and stops the gating of the A numbers into storage. By this means the A number section of the register remains reset to zero. The output of the multiplier therefore becomes zero also, and the number accumulated in the integrator is recorded. This is the value of $\phi(\tau)$ for the particular value of τ being used. The integrator is then reset to zero, and the value of τ is changed in the timing equipment by changing the separation of the A and B timing pulses. The operations of recording $\phi(\tau)$, resetting the integrator, and changing τ are completed in about two seconds. When the number stop gating pulse ends, the machine begins the computation of ϕ for the new value of τ.

Circuit Features

We now proceed to a somewhat more detailed discussion of those parts of the machine which are especially important in meeting the design specifications listed above.

Timing Equipment

Fig. 3 is a block diagram of the portion of the timing equipment which is used in obtaining the A and B timing pulses. These timing pulses must be accurately spaced,

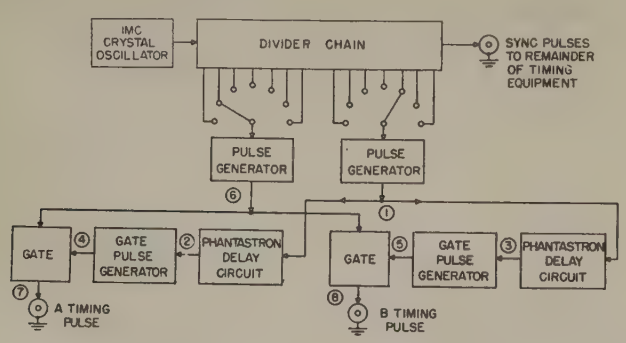


Fig. 3—Block diagram of timing equipment.

since it is their separation which defines τ. A 1-Mc crystal oscillator is used as a reference. The output of the oscillator drives a pulse generator which in turn feeds a cascade of bistable multivibrators. A square wave is taken from one of the latter stages in the cascade to govern the repetition rate at which A and B timing pulses are produced, and therefore the rate at which multiplications are carried out. This rate may be as great as approximately 1,000 per second for small values of τ, but must be decreased as the value of τ increases. Normally the rate is set low enough to include the maximum value of τ used in any one correlation function, and is not changed throughout the computation. By means of the pulse generator, a pulse obtained from one edge of the square wave triggers the phantastrons, and these trigger gating pulse generators whose outputs are set to have a duration equal to the steps in τ which are to be used in the problem under consideration. The gate pulse generators turn on the gates during the occurrence of one of a train of pulses obtained from an earlier stage in the divider cascade. This latter pulse train has a repetition period equal to the desired steps in τ. Numbered wave forms are shown in Fig. 4. The steps in τ which are available by this method range from 1 μsec to 2^{10} μsec. Smaller steps in τ are obtainable by making use of the trailing edges of the phantastron

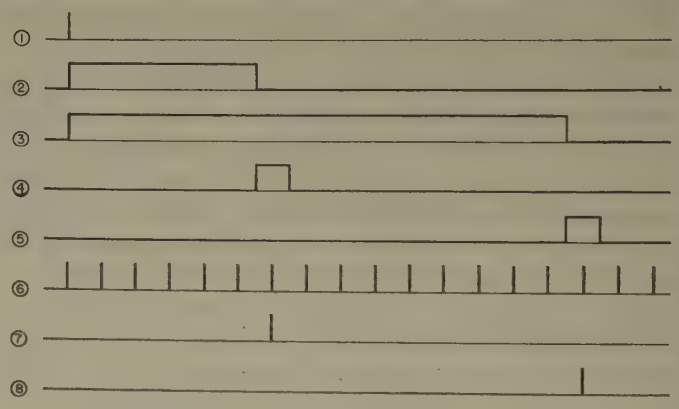


Fig. 4—Wave forms at numbered points of Fig. 3.

outputs directly. By this means, increments in τ as low as 0.02 μsec can be obtained. The phantastron plate catching voltage is under control of a stepping relay which produces 110 different voltages in succession. A particular value of τ corresponds to each position of the stepping relay, and the relay changes after each value of $\phi(\tau)$ is recorded. The maximum range of τ is 110×2^{10} μsec, or about 0.1 sec.

Sampling and Coding Circuits

In order to produce a binary digital representation of the amplitude of the input signal at the time of sampling, the corresponding box car is first converted to a pulse having a duration proportional to the box-car amplitude. The duration-modulated pulse is then used to gate a train of timing pips to a binary counter. The counter is reset to zero prior to the occurrence of each

duration-modulated pulse, so that the condition of the counter at the end of the duration-modulated pulse is a binary representation of the box-car amplitude.[10] It is evident that the only important errors produced by the correlator must lie in these circuits, that is, in the box-car generator and in the duration-modulated pulse generator. The duration-modulated pulse is obtained by intersecting the box car with a saw-tooth wave form, and marking the instant of equality of the two voltages. Thus the critical portions of the duration-modulated pulse generator are the saw-tooth wave-form generator and the comparison circuit used to indicate equality between the saw-tooth and the box car. The box-car generators, saw-tooth generator, and comparison circuit are therefore discussed next. A block diagram showing the interconnection of these circuits is given in Fig. 5. The operation indicated by the diagram can be followed with the aid of Fig. 6, which shows wave forms for numbered points on the diagram.

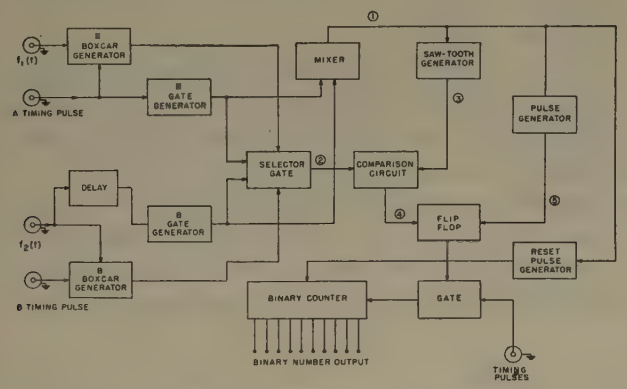


Fig. 5—Block diagram of number generator and associated circuits.

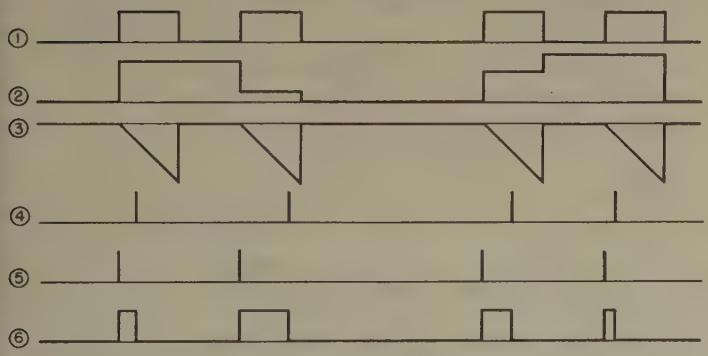


Fig. 6—Wave forms at numbered points of Fig. 5.

Box-Car Generator

A block diagram of one of the box-car generators is shown in Fig. 7. There are two of these circuits, one for each channel. The input timing pulse is reshaped for uniformity in a blocking pulse generator, which produces a very sharp sampling pulse a little less than 0.1 μsec. in duration. The sampling pulse is applied to the suppressor grid of a 6AS6 gate tube normally biassed

[10] Y. W. Lee, "Experimental Determination of System Functions by the Method of Correlations," Quart. Progress Rep., Res. Lab. of Electronics, MIT, p. 60; January 15, 1950.

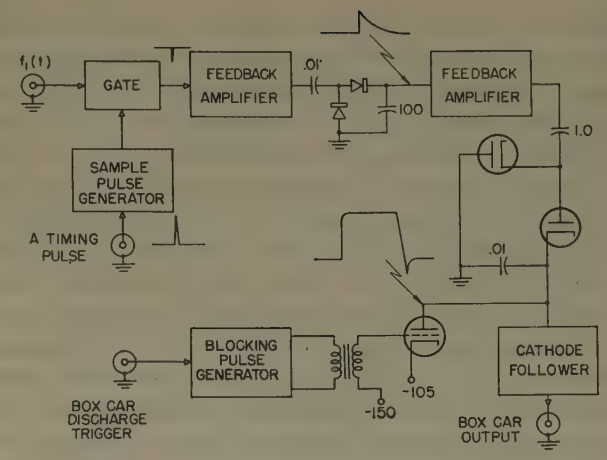


Fig. 7—Block diagram of box-car generator.

below plate current cutoff, and the input time series is applied to the control grid. The need for a very narrow sampling pulse and a wide, flat-topped output pulse imposes conflicting requirements on the box-car generator. The wide output pulse is obtained by storing charge on a condenser. In some cases use is not made of the stored sample until about 600 μsec have passed. In order that the charge not decay appreciably during this interval, a large condenser (0.01 μf) is used. Discharging through a leakage resistance of say 40 megohms, the time constant is 400 milliseconds, and this is satisfactory. Charging through a resistance of 500 ohms, however, which is the order of magnitude that can be easily obtained, the charging time constant is 5 μsec. and a 0.1-μsec pulse is not wide enough. The conflicting requirements are met by widening the original 0.1-μsec sample in successive stages, as shown in Fig. 7.

Saw-Tooth Generator

A schematic diagram of the saw-tooth generator is shown in Fig. 8. This is a Miller feedback circuit using three stages of gain, and gives extremely good linearity. Generation of the saw tooth takes place during the presence of a gating pulse on the normally cut-off suppressor of the first stage of the amplifier. Temperature drift affecting the saw-tooth slope is compensated by returning the resistor of the *RC* combination which determines the slope to a variable voltage under control of the first or

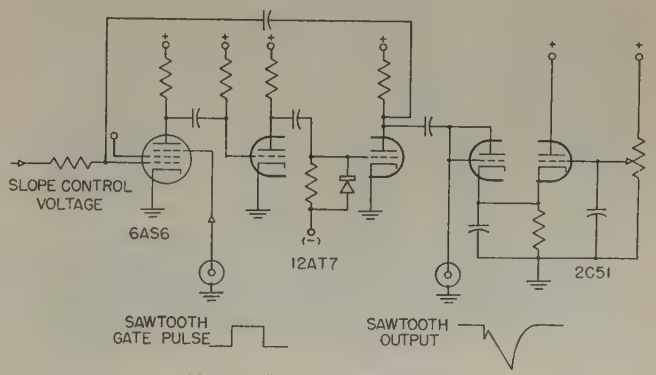


Fig. 8—Saw-tooth generator.

principal digit in the *B* channel of the output of the number generator. The output of the number generator ranges from 0 to 1,023. If the first digit is one, the output is equal to or greater than 512. If the first digit is zero, the output is less than 512. The voltage applied to the slope control resistor is proportional to the relative frequency of occurrence of one in the first digit, and is of the proper polarity to decrease the size of the number if the relative frequency is greater than 50 per cent. Thus the average value of the output of the number generator is held very closely to 512. Use of this drift compensation circuit has reduced errors due to long term drifts in the correlator to negligible importance.

The manner in which the slope control voltage is obtained is shown in Fig. 9. A reset pulse is applied to the flip-flop just before the *B* number is gated into storage.

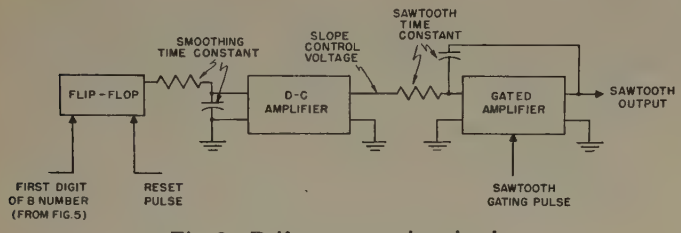


Fig. 9—Drift-compensating circuit.

When the *B* number is gated into storage, the flip-flop is triggered if the first digit of the *B* number is one; otherwise the flip-flop remains in the reset condition. The output of the flip-flop is therefore essentially a rectangular wave whose polarity is dependent on the current value of the first digit of the *B* number. This rectangular wave is smoothed in an *RC* circuit whose time constant is long compared to the sampling period. The resulting voltage is amplified in the dc amplifier and used to control the slope of the saw-tooth generator.

Comparison Circuit

A schematic diagram of the comparison circuit is shown in Fig. 10. The saw tooth is applied to the grid of V1 and the box-car to the grid of V2. As the saw tooth passes through a narrow range of voltage in the neighborhood of the box-car voltage, the plate current of V1 shifts to V2. No triggering is involved, since no regeneration is present. Because of the pentode V3 in the common cathode circuit of V1 and V2, the plate current of V2 after the shift is equal to the plate current of V1 before the shift. This causes the voltage swings across the plate resistor of V1 and V2 to be equal, and allows fixed grid biasses to be used in V4 and V5. The grids of V4 and V5 are driven in push-pull. A narrow slice is taken near the midpoint of the grid swing, and appears in amplified form at the plate of V4. The resulting essentially rectangular wave form is applied to a regenerative amplifier, or trigger circuit, which derives a sharp pulse from the leading edge of the rectangle. This sharp pulse is used to reset a flip-flop (not shown on Fig. 10, see Fig. 5) previously triggered by the leading edge of the saw-tooth gate. The wave form at the plate of the flip-flop is the required duration-modulated pulse. It is used, as has been indicated, to gate the timing pulse generator which drives the binary counter in the number generator.

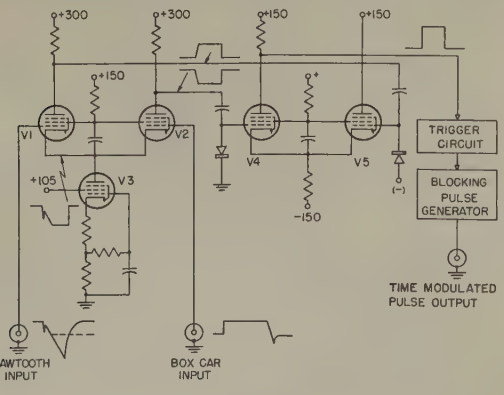


Fig. 10—Comparison circuit.

High-Speed Counter

Very little need be said about the binary counter in the number generator. Since 10 digits are used, a maximum of 1,023 pulses may be counted. In order not to take too long in the counting, a 5-Mc repetition rate is used for the pulses to be counted, thus requiring at most 200 μsec. The first stage of the counter is shown in Fig. 11. The circuit was tested for several weeks at 10 Mc before being incorporated into the equipment. The essential feature of the circuit, which allows it to operate ate the unusually high speed, is that crystal diodes from the grids to a tap on the cathode resistor are used to discharge the coupling capacitors *C* through the low input impedance of the opposite tube. This permits the use of large coupling capacitors (100 μμf in this case) and still permits the coupling capacitors to discharge quickly after each triggering to a voltage from which the flip-flop can again be triggered.

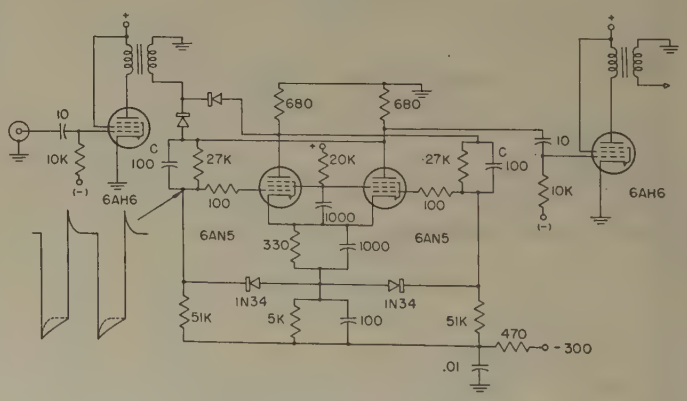


Fig. 11—High-speed counter.

Register and Multiplier

After each of the numbers for the two input channels is generated, it is gated into storage in the number register (see Fig. 12). The register consists of two sets

of ten flip-flops each, one set for each of the two numbers to be multiplied, and includes means for shifting the A numbers to the left and the B numbers to the right. Although ten digits are stored in each register, for simplicity only four stages of each are shown in Fig. 12. Assuming that a number is in one of the registers, shifting may be accomplished by applying a shift pulse which rests all of the flip-flops to zero. Associated with each flip-flop is a monostable delay multivibrator. Any flip-flop in state one has its state changed by the reset, and produces a pulse which triggers its associated delay multivibrator. The trailing edge of the delay multivibrator is used to set the next flip-flop to one. Thus each symbol of the stored numbers is moved one stage to the left (in the upper register) or to the right (in the lower register). The shifting operation is made use of during the process of multiplication, in a manner to be described below.

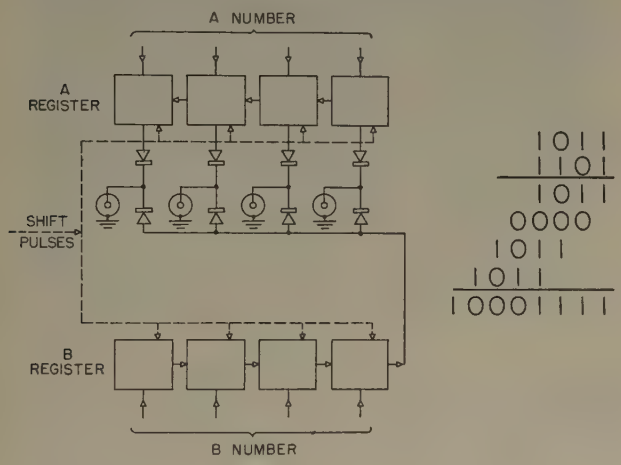


Fig. 12—Block diagram of part of number register.

We first note the numerical example of binary multiplication which is also shown in Fig. 12. The multiplication is carried out in a manner analogous to decimal multiplication, as follows: (1) each digit of the upper number is multiplied by the digit occupying column four of the lower number, and the result is written in the highest empty spaces directly under the upper number; (2) the upper number is shifted one space to the left and the lower number one space to the right; (3) steps (1) and (2) are repeated until all digits have been used; (4) the partial products obtained with each step (1) are summed to give the complete product.

In the machine the process is exactly similar. The value of each partial product is present between shift pulses in the state of the rectifier coincidence circuits shown in Fig. 12. The connection from the register flip-flops to each coincidence circuit is such that if the two corresponding flip-flops are in state one, the output voltage of the coincidence circuit is zero; otherwise it is a large negative voltage. Each coincidence circuit output voltage is used to control the suppressor grid of a 6AS6 gate tube. Application of a positive exploring pulse to the control grid of the gate tube therefore results in a pulse at the gate tube plate only if the two corresponding flip-flops are in state one. The first partial product is present in the state of the coincidence circuits as soon as both numbers are stored. This partial product is read off into the accumulator, or integrator, by applying exploring pulses to the control grids of the gate tubes in time sequence. Trigger pulses occur at the plates of some of the gate tubes and these are used to trigger appropriate stages in the integrator. As soon as all the coincidence circuits have been read, a shift pulse is sent to the register, and the reading process is repeated. This sequence of operations continues until only zeros remain in the register. The shift pulses are then stopped. We observe that the sequence of outputs of a given coincidence circuit corresponds to the numbers in a particular column of the sum of partial products in the numerical example of binary multiplication noted earlier. Hence the output of a given 6AS6 gate tube is always used to trigger the same stage in the integrator. The two ten-digit binary numbers are multiplied together in 250 μsec, once they are both present in the register.

Integrator and Recorder

As has been indicated, the integrator comprises a cascade of scale-of-two circuits, or flip-flops. A multiple pen Esterline-Angus Recorder is connected to the last ten stages of the integrator, and the condition of these stages is read into the recorder at the end of each integration period. The integrator is then reset preliminary to beginning a calculation with the next value of τ. A switch is provided for skipping one or more of the intermediate stages in the integrator, in order that the ten stages recorded may always represent the most significant part of the result. At the same time that the digits are recorded, they are decoded in a voltage adding circuit, and the result is recorded on a General Electric Recording Microammeter. The decoded recording is useful in test runs for immediate observation of results, but is not as accurate as the digit recording.

Sample Results

Fig. 13 shows the correlation function of a sine wave as evaluated and plotted by the machine. The steps in τ are four microseconds.

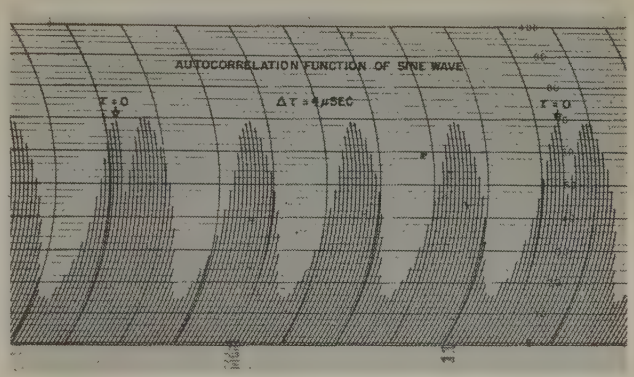


Fig. 13—Autocorrelation of sinusoid.

Fig. 14 shows the correlation function of a limited wave produced by passing wide-band (3 Mc) noise through an RC integrator (5-μsec time constant), and then limiting the output of the integrator to produce a rectangular wave.

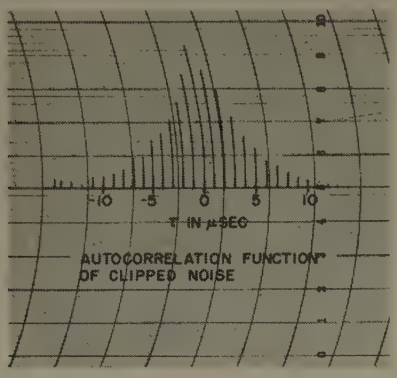


Fig. 14—Autocorrelation of clipped noise.

Fig. 15 shows the correlation function of a rectangular wave with independent random zero crossings.[11]

Fig. 16 shows the convolution integral

$$\int_0^\infty e^{-|\tau-\sigma|/T_2} e^{-\sigma/T_1} d\sigma$$

obtained by taking the cross correlation of the output and input of an RC circuit ($T_1 = 50$-μsec time constant). The input circuit was obtained by passing wide-band

[11] Obtained from equipment designed by C. A. Stutt.

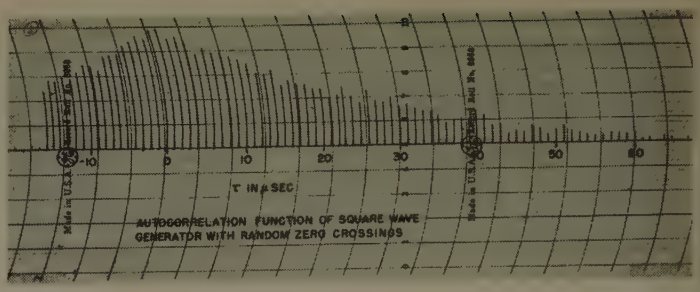


Fig. 15—Autocorrelation of random square wave.

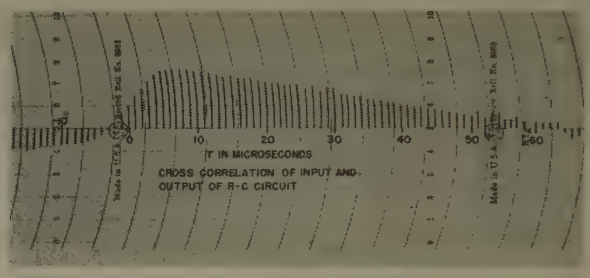


Fig. 16—Convolution of exponentials.

(3 Mc) noise through an RC ($T_2 = 5$-μsec time constant) integrator.[10]

ACKNOWLEDGMENT

The writer wishes to express appreciation to J. B. Wiesner and Y. W. Lee for the supervision of this project, and to T. P. Cheatham, W. B. Davenport, R. M. Fano, L. G. Kraft, A. J. Lephakis, and C. A. Stutt for their generous assistance on numerous problems connected with the design and testing of the machine.

Some Aspects of Split-Anode Magnetron Operation*

H. J. REICH†, FELLOW, IRE, J. C. MAY†, MEMBER, IRE, J. G. SKALNIK†, ASSOCIATE, IRE, AND R. L. UNGVARY‡, MEMBER, IRE

Summary—Tests of split-anode magnetrons used with butterfly resonators have shown that resonators and tubes at present available are not suitable for use in wide-band butterfly magnetron oscillators, but that such oscillators might have desirable characteristics in some applications if the tubes and resonators were designed for the purpose.

Oscillographic studies appear to indicate that negative slope of portions of the anode current-voltage characteristics can be explained on the basis of back-heating and that negative slope is absent when the current is varied rapidly.

A comparison of various methods of anode-current stabilization showed that smoothest operation is obtained if the magnetic field is produced by an electromagnet excited by the direct anode current.

* Decimal classification: R355.912.1. Original manuscript received by the Institute, June 2, 1949; revised manuscript received, March 24, 1950.

† Yale University, New Haven, Conn.
‡ Raytheon Manufacturing Company, Waltham, Mass.

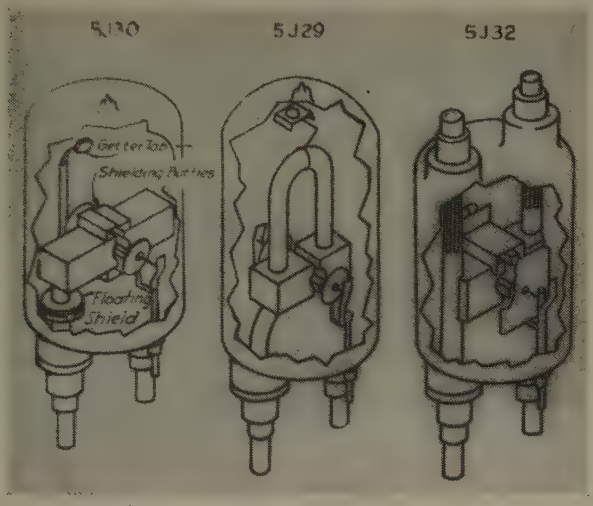
I. INTRODUCTION

CONSIDERABLE material is available in the literature on the pulsed operation of cavity magnetrons. The treatment of continuous-wave (cw) operation of split-anode magnetrons, however, is

less extensive, and the purpose of this paper is to discuss some of the characteristics of these tubes and their associated circuits.

II. Description of Tubes and Circuits

The magnetrons used were General Electric Company 5J29, 5J30, and 5J32 split-anode magnetrons. The 5J30, shown in Fig. 1(a), has no internal loop and therefore may readily be operated at frequencies as low as a few megacycles per second with an external quarter-wave line. The 5J29, shown in Fig. 1(b), contains an internal loop between the two anode segments. The



(a) (b) (c)

Fig. 1—Split-anode magnetrons.

loop increases the maximum frequency that may be obtained but reduces the tuning range. The double-ended 5J32, shown in Fig. 1(c), was used principally in butterfly-tuned oscillators discussed in Section III. The general form of one oscillator circuit used in this work is shown in Fig. 2(b). Fig. 2(a) shows the manner in which the magnetic field was applied, and Fig. 2(c) the way in which cooling-water connections were made to the anode leads of the tubes.

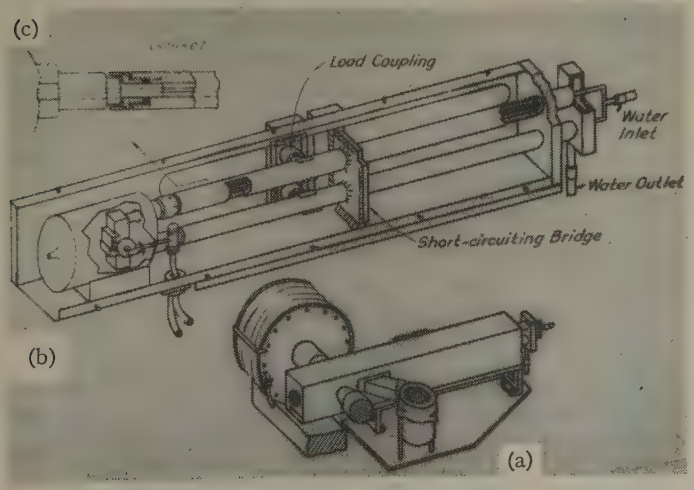


Fig. 2—Magnetron oscillator assembly.

Not only must the anodes of split-anode magnetrons be water-cooled, but the filament leads and the entire envelope must be air-cooled. Uniform cooling of the envelope is important. The internal loop of the 5J29 allows the cooling water to enter through one anode lead and leave through the other. In the 5J30 and 5J32, however, the water must enter both anodes through small concentric tubes contained within the tubular lines and leave through the lines, as shown in Fig. 2. The inner tubes must extend into the anodes in order to provide proper cooling.

III. Butterfly-Tuned Oscillators

If the standard type of butterfly tuner could be adapted to serve as a resonator for a split-anode magnetron, several advantages over parallel-line oscillators could be achieved: (1) the physical size of the oscillators could be greatly reduced; (2) the tuning mechanism would be much simpler; (3) the position of the load-coupling point could be made independent of tuning; and (4) the tendency toward resonance-mode jumping would be greatly reduced.

The materials available for the construction of such an oscillator are not what might be desired. First, the butterfly tuners available are all low-power receiver units whose voltage ratings are far below the magnetron requirements. Second, the magnetrons available have all been built for use in parallel-line systems and thus are not ideally suited for connection to the butterfly tuner. The primary difficulty turns out to be the length of line between the electrodes and the butterfly. The butterfly tends to act as a capacitive short circuit on a short section of line made up mainly of the tube leads. The frequency range is therefore much smaller than that of the butterfly resonator itself.

Several oscillators working on this principle were built and fair operational results were obtained. One of the butterfly tuners used is shown in Fig. 3. The load was coupled, in general, directly to the short section of parallel line connecting the tube and the tuner.

Arcing inside the tuner due to insufficient spacing was a frequent occurrence. In an endeavor to increase

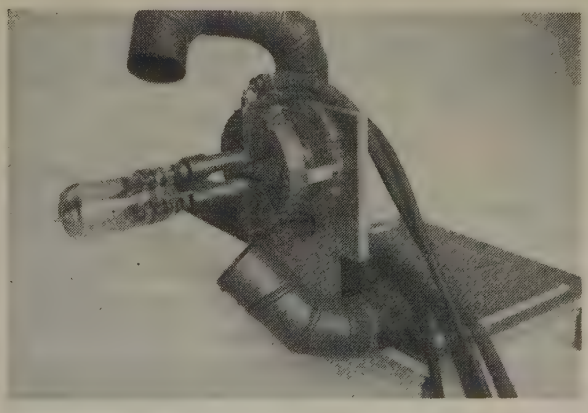


Fig. 3—Butterfly-tuned magnetron oscillator.

the spacing of available types, some units were dismantled and reassembled with different stacking arrangements. As might have been predicted, these units were not ideal resonators, having many spurious modes. One of the oscillators built, which used a 5J30 tube, had a frequency range from 127 to 385 Mc and a maximum power output of approximately 500 watts at 385 Mc.

The butterfly tuner could be more successfully used in conjunction with split-anode magnetrons if the current types of butterfly tuners and magnetrons were modified for the purpose. A tube could be built with much shorter leads and the butterfly spacing might be changed. Since small size is desirable, however, the ideal solution might well be to include the butterfly tuner within the magnetron envelope. The disadvantage of such a structure would be the increased complexity of tuning

IV. Amplitude-Modulation Characteristics

Fig. 4 shows typical characteristics of average anode voltage versus average anode current for a split-anode magnetron at fixed magnetic flux density and several values of filament current. These characteristics were obtained with the magnetron oscillating, but each point on the curves was taken with fixed values of direct anode current and voltage. Characteristics obtained in this manner will be termed "static current-voltage characteristics," in contrast with characteristics obtained with periodically varying average current and voltage, which will be termed "dynamic current-voltage characteristics."

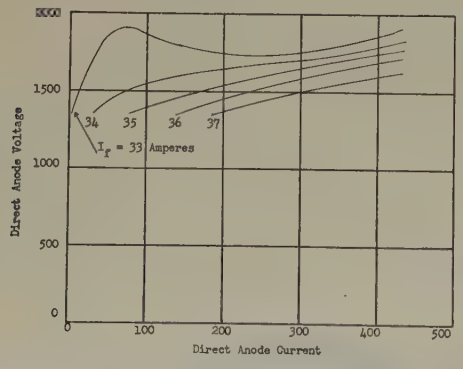


Fig. 4—Typical characteristics of average anode voltage versus average anode current for a split-anode magnetron at fixed magnetic flux density.

An interesting feature of the characteristics of Fig. 4 is the negative slope observed in certain ranges of filament current. This negative slope would be expected to result in unstable operation when the tube is amplitude-modulated by variation of anode current. Experience in the use of split-anode magnetrons at the Radio Research Laboratory during the war, however, showed that stable amplitude modulation could be obtained. These facts suggest that the static current-voltage characteristics do not hold under dynamic conditions, and led to the oscillographic determination of dynamic characteristics.

The circuit used in the determination of dynamic characteristics is shown in Fig. 5. By means of this

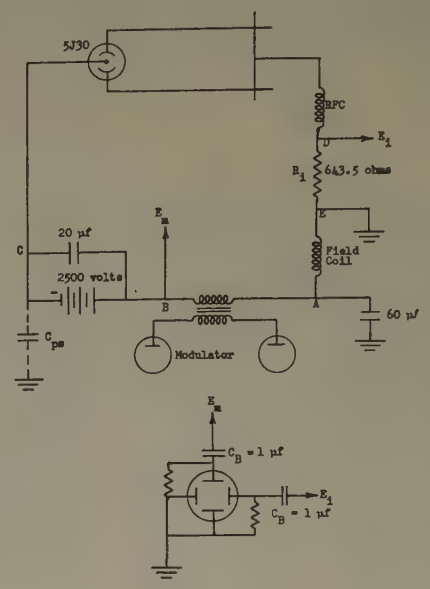


Fig. 5—Circuit used in the determination of the dynamic characteristics of split-anode magnetrons.

circuit the current could be varied periodically about an operating value at any frequency within the range from 500 cps to 5,000 cps. The voltage across the resistor R_i, which is proportional to the instantaneous magnetron current, was impressed across the x-deflection plates of an oscillograph tube, and the applied modulation voltage was applied across the y-deflection plates. The instantaneous anode voltage was found by subtracting the instantaneous voltage across R_i from the instantaneous applied voltage, i.e., subtracting the x-deflection from the y-deflection. In this manner dynamic curves of alternating anode voltage versus alternating anode current were obtained.

In the study of dynamic characteristics, most of the data were obtained with the butterfly-tuned oscillator of Fig. 3 because of its compactness, ease of tuning, and relative freedom from mode jumping. Comparison with a parallel-line resonator showed that the dynamic characteristics are not noticeably dependent upon the type of resonator used.

In order to avoid modulation resulting from an alternating component of magnetic flux, the magnetron filaments were operated on direct current.

With the equipment used, it was not possible to modulate over a sufficient range of current to obtain the entire dynamic characteristics, and the various portions of the curves could not be obtained separately and combined because of the change of filament temperature with average anode current as the result of back-heating. For the limited current swings obtainable, how-

ever, the dynamic curves, unlike the static curves, always show a positive slope and show little or no curvature. Because of the small curvature, the slope of the dynamic curves at various operating points may be assumed to be equal to the ratio of the rms value of the alternating component of anode voltage to the rms value of the alternating component of plate current. The curves of Fig. 6, showing rms anode current versus

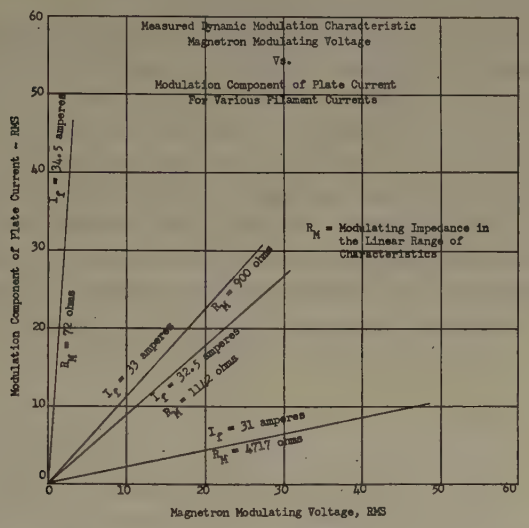


Fig. 6—Dynamic modulation characteristics of a split-anode magnetron for four values of filament current.

rms anode voltage at four values of filament current, indicate that this assumption is justified over a limited range of operation, and it is therefore unnecessary to use oscilloscopic techniques except to check the linearity. Curves of detected output versus modulating voltage were essentially linear. Although the entire dynamic characteristics could not be obtained experimentally, the decrease in slope of the dynamic characteristics with increase of filament temperature at both constant anode current and constant anode voltage indicates that the complete family of dynamic characteristics is of the general form shown in Fig. 7.

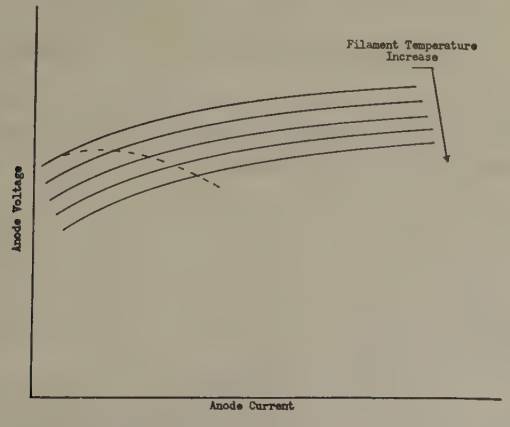


Fig. 7—Static characteristic curve predicted from dynamic characteristics.

The difference between static and dynamic characteristics can be explained on the basis of back-heating. Under dynamic conditions the average anode current remains constant throughout the cycle and therefore back-heating and filament temperature remain constant. The static characteristics, on the other hand, are obtained by varying the average anode current at constant filament current. As the average anode current is increased, increased back-heating raises the filament temperature. (The increase in temperature is clearly visible in these tubes.) Since the exact form of the dynamic characteristics and the manner in which filament temperature depends upon anode current are not known, the shape of a static characteristic cannot be predicted exactly from a family of dynamic characteristics. The assumption that filament temperature increases with anode current because of back-heating under static conditions results in a predicted static characteristic of the general form of the dashed curve in Fig. 7. Whether the slope of any portion of the predicted curve is negative or positive depends upon the slope and spacing of the constant-filament-temperature (dynamic) curves and upon the manner in which filament temperature varies with average anode current, but the theory shows that the static characteristics might be expected to have negative slope in at least a portion of the operating region. It also suggests that negative slope, which may result in unstable operation (see Section V), could be prevented if the effect of back-heating upon filament temperature could be made small in comparison with the effect of filament heating current. This is probably the explanation of the fact that only the 33-ampere curve of Fig. 4 shows negative slope.

The marked differences between the static and dynamic characteristics of split-anode magnetrons indicated clearly that the modulation resistance of these tubes in amplitude modulation cannot be determined from static current-voltage characteristics. The modulation resistance may be readily determined, however, from measured values of modulation-frequency anode current and voltage in a circuit of the form of Fig. 5.

V. Limitation of Anode Current

The 33-ampere curve of Fig. 4 shows that if the anode voltage is gradually raised, the anode current will increase in a stable manner until the voltage reaches the value corresponding to the peak in the curve. Beyond this value of voltage, however, the voltage required across the tube decreases as the anode current increases, and therefore, if the voltage supply has good regulation and the anode-circuit resistance is low, the current will rise abruptly to a value of 400 to 500 ma. Under some operating conditions the anode current may suddenly rise to values that are sufficiently high to cause damage or destruction of the tube. Abrupt changes in current are obviously objectionable in the amplitude modulation of the tube.

The simplest method of stabilizing the circuit against abrupt increases of current is to use resistance in series with the anode. The manner in which stabilization occurs can be readily seen by the use of a "load line" in the current-voltage diagram, in a manner analogous to that used in the analysis of amplifier tubes. Through a point of the voltage axis corresponding to the anode supply voltage, a line is drawn with negative slope equal in magnitude to the anode circuit resistance, as shown in Fig. 8. If the resistance is high enough so that the magnitude of the slope of this load line exceeds the

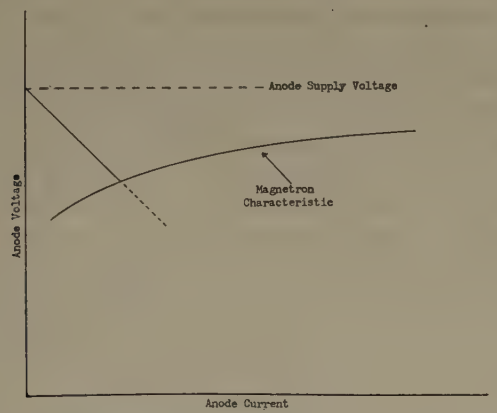


Fig. 8—Limitation of anode current by series resistance.

highest magnitude of the negative slope of the tube characteristic, only one intersection is obtained. There can then be only one stable value of current, and an abrupt increase of anode current at constant anode supply voltage cannot occur. The objection to this solution of the problem lies in the power loss in the series resistance.

A more common method of stabilization is the use of a power pentode, or of a parallel combination of two or more pentodes, in series with the magnetron cathode. In the operating range of power pentodes the plate current varies comparatively little with plate voltage, but is determined principally by the control-grid voltage.

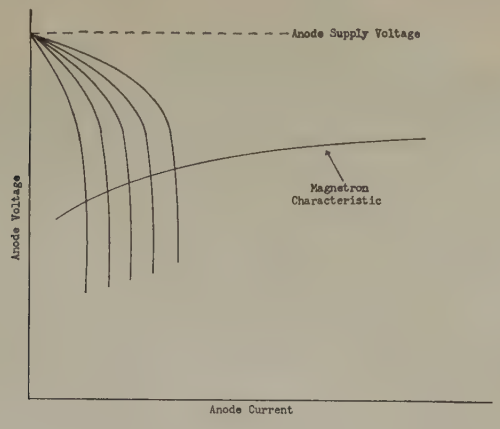


Fig. 9—Limitation of anode current by series pentodes.

The anode diagram of Fig. 9, in which the load line of Fig. 8 is replaced by the family of pentode plate characteristics (pentode plate voltages are indicated as a voltage drop relative to the supply voltage), shows the manner in which stabilization is obtained. In addition to the lower power loss and lower plate supply voltage required, the pentode method of stabilization has the advantage that current modulation of the magnetron can be produced by applying a relatively small modulating voltage to the pentode grids.

A third method of stabilization is the use of a circuit in which the filament current is automatically reduced as the anode current increases. The objection to this method of stabilization is the thermal inertia of the filament and increased low-frequency pulsing.

A fourth method of stabilization consists of the use of an electromagnet, excited by the anode current, to provide the magnetic flux for the magnetron. Fig. 10 illustrates the mechanism of stabilization. Increase of

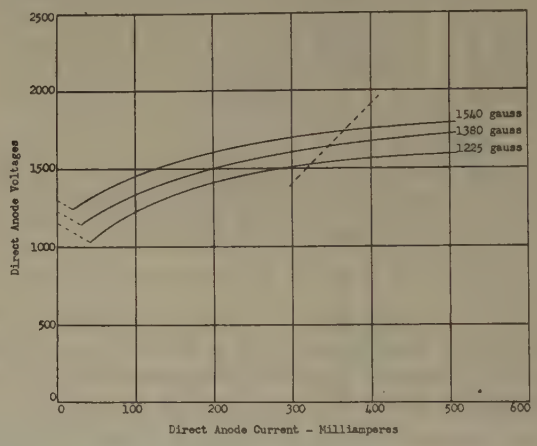


Fig. 10—Limitation of anode current by means of an electromagnet excited by the magnetron anode current.

anode current is accompanied by a proportional increase of flux density. The static path of operation is therefore of the form shown by the dashed curve. The slope of the static characteristic is effectively increased, and negative slope is avoided. This method of stabilization has been used previously on cavity magnetrons.

VI. Series-Magnet Stabilization

Fig. 11 shows static current-voltage characteristics for a 5J29 tube operated with series field excitation. The four curves correspond to four values of number of turns on the electromagnet. An advantage of the use of this type of stabilization is that oscillation is obtained at much lower values of anode voltage than with constant flux; and that the amplitude of oscillation can be increased smoothly over a wide range by increasing the anode voltage.

The breaks in the characteristics of Fig. 11 for the smaller number of magnet turns indicate pulsing

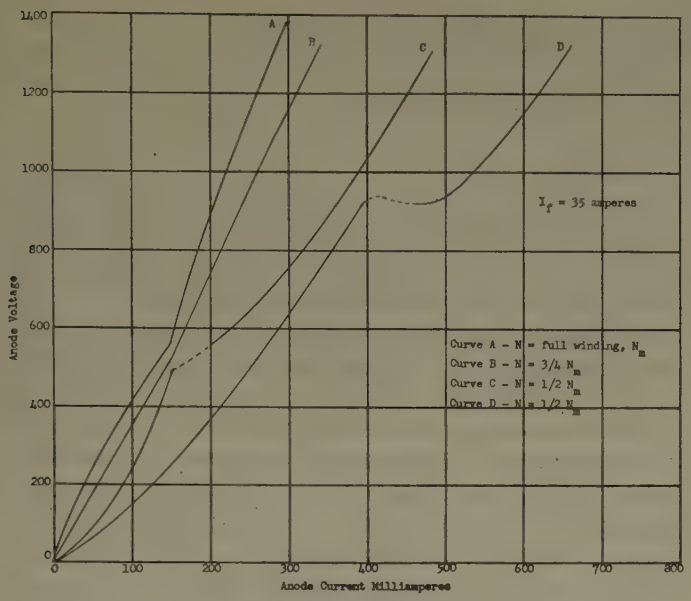


Fig. 11—Static current-voltage characteristic for a split-anode magnetron with series field excitation.

(periodic variation of amplitude), due to improper loading. In general, the tendency toward low-frequency pulsing is very much lower with series-magnet excitation than with permanent-magnet excitation.

It is apparent from Fig. 11 that the steepness of the static characteristics with series excitation increases with the number of turns on the electromagnet. This suggests that operation at essentially constant current should be possible if the rate of change of flux with anode current can be made sufficiently great. This result was accomplished by the circuit of Fig. 12. In this circuit the magnet current is controlled by a number of 304-TH power tubes in parallel, which are in turn controlled, through the 6SK7 amplifier stage, by the voltage drop across the resistor R_1 in the cathode circuit of the magnetron. In this manner the change of magnet current is made much greater than the change of magnetron anode current, and the operating anode current is made essentially independent of operating voltage.

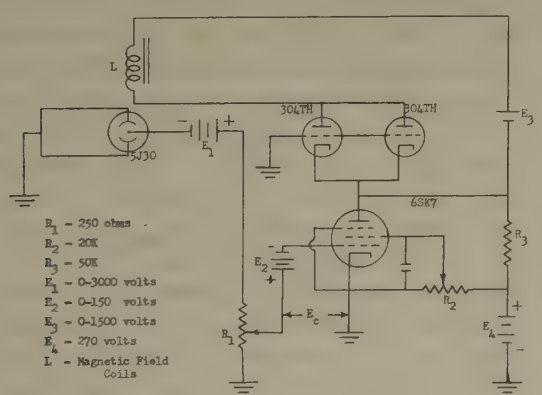


Fig. 12—Circuit for constant-current operation of a split-anode magnetron.

Fig. 13 compares static current-voltage curves for a 5J30 operated with fixed magnetic field, with series-excited magnetic field, with amplifier-controlled magnetic field (circuit of Fig. 12), and with constant magnetic field and series pentodes. Fig. 14 shows corresponding curves of power output versus anode current.

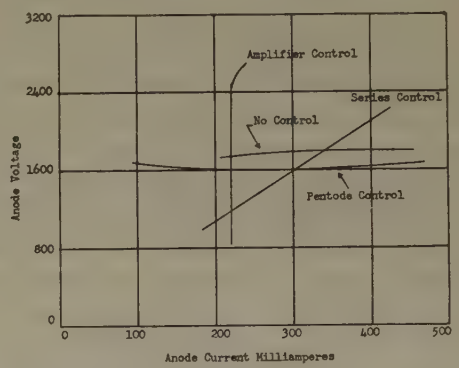


Fig. 13—Comparison of static current-voltage curves for different methods of operation.

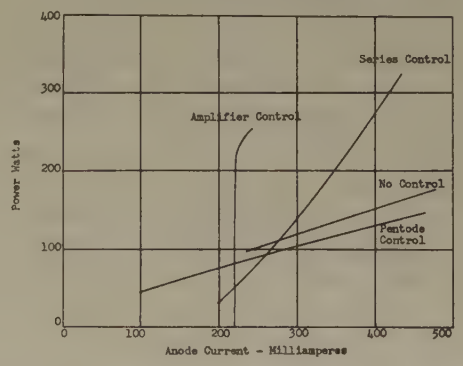


Fig. 14—Curves of power versus current for different methods of operation.

VII. Acknowledgment

The work upon which this paper is based was conducted under research contract N6ori-44 with the Office of Naval Research.

Effects of Space Charge on Frequency Characteristics of Magnetrons*

H. W. WELCH, JR.†, ASSOCIATE, IRE

Summary—**Properties of the magnetron space-charge swarm which affect the propagation of electromagnetic waves are defined in terms of an effective dielectric constant. The space charge is found to be doubly refractive in nature, the velocity of propagation depending on the direction of propagation of the wave, polarization of the wave, and frequency. Effects of synchronism of the rotating space-charge swarm are discussed qualitatively. Experimental results which check parts of the theory are presented. The relationship of the space charge to the circuit is discussed in terms of the nonoscillating and the oscillating magnetron.**

Introduction

THE COMPLETE DISCUSSION of space-charge effects on frequency characteristics of continuous-wave magnetrons requires attention to a varied subject matter. Much of this subject matter has been treated in reports of government agencies and in the journals, and is generally understood. There are, however, several points at which present knowledge becomes inadequate background for an understanding of the mechanism of magnetron operation. This is particularly the case when one is to predict quantitatively the behavior of magnetron space-charge clouds under the influence of radio-frequency fields.

The circuital aspects of magnetron frequency characteristics are generally treated by establishment of an equivalent circuit and interpretation of that equivalent circuit in terms of experimentally measurable quantities. The most conveniently measurable quantities are resonance wavelength, loaded Q, and minimum standing-wave ratio. The relationships between these quantities and other unmeasurable quantities in the equivalent circuit are fairly well defined and understood. This theory can be extended to explain semiquantitatively effects of the output circuit and load on magnetron frequency characteristics such as frequency pulling and long-line effect.

Frequency characteristics of an operating magnetron must be obtained from the following types of experimentally obtained information: Rieke diagrams, relating frequency of oscillation and power output to load characteristics; frequency pushing measurements, relating frequency and plate current for constant loading; and modulation characteristics determined by spectral measurements of various types. Interpretation of these types of data depends on knowledge of the physics of space-charge effects in the oscillating magnetron and, at this point, is almost entirely qualitative.

Another type of data, resulting from measurements made on magnetrons in which electrons are circulating but not reaching the anode, is very useful as an aid to the understanding of space-charge behavior. The method of measurement is the same as that used for cold impedance tests on microwave tubes and resonant cavities. In order to differentiate, the term "hot impedance test" is used, implying that the magnetron is "hot" and capable of drawing plate current if the conditions of anode voltage and magnetic field are proper adjusted.

In order to provide theoretical interpretation of the experimental results, it is necessary to study two types of properties of the space charge. These are the following:

Type 1—Properties having to do with the distribution of angular velocity, field, potential and charge density, and definition of the space-charge boundary in the magnetron interaction space.

Type 2—Properties having to do with the propagation of electromagnetic waves in the space-charge distribution defined by the results of the study of properties of Type 1.

The results of the study of properties of Type 1 will be presented when needed but not derived in this paper. The primary purpose will be the detailed discussion of properties of Type 2 and interpretation of the various effects of space charge on magnetron frequency characteristics. It will be pointed out that these effects result from three more-or-less separate phenomena which may occur together or separately. The picture is still incomplete experimentally, because of very large quantities of data which are necessary to survey the entire range of the variable parameters, and, theoretically, because of the complexity of parts of the necessary mathematical development. Another important factor is that, in most conventional magnetrons, the total effect of space charge on frequency is a shift of less than one or two per cent. A detailed study therefore requires a number of measurements accurate within at least 0.1 per cent.

The need for the study of space-charge effects on frequency characteristics lies in two directions. In the first place, it becomes possible for experimental results to provide a check on the basic theories of the magnetron space charge. In the second place, understanding of the use of the magnetron space charge in electronic frequency control or modulation is increased.

* Decimal classification: R138.1×R355.912.1. Original manuscript received by the Institute, October 10, 1949; revised manuscript received, May 25, 1950.

This paper is based on work done for the Signal Corps of the United States Army, under Contracts W36-039 sc-32245 and 36-039 sc-35561.

† Engineering Research Institute, University of Michigan, Ann Arbor, Mich.

The various conditions under which data may be taken give a wide range of possibilities for interpretation. In certain cases quantitative agreement between theory and experiment are obtained. The present paper is not meant to be a complete and final analysis of the problem of magnetron space-charge and frequency characteristics. It is intended to relate as many as possible of the known facts and theories in such a way that they can be used as a guide for further research and development. Gaps in both experimental data and theory will be pointed out with the hope that someone will have the necessary information, or the time to acquire the necessary information, to fill them in.

Formation of the Magnetron Space Charge

The static cylindrical magnetron space-charge distribution, which is often called the Hull or Brillouin solution, may be thought of as a swarm of electrons revolving around the cathode. This swarm is characterized by the condition that no radial current exists and by the following angular velocity distribution:

$$\omega = \frac{Be}{2m}\left(1 - \frac{r_c^2}{r^2}\right) \tag{1}$$

where

B = axially directed magnetic field
r_c = cathode radius
r = radius which locates electron
e = absolute value of electronic charge
m = electronic mass.

However, assuming no energy exchange with the surroundings, this distribution of angular velocity must exist in the static magnetron regardless of the radial velocity, initial or otherwise. If no radial velocity is present, then the corresponding potential distribution represents minimum energy of the electrons.

$$Ee = \frac{1}{2} m \left(\frac{Be}{2m}\right)^2 r^2 \left(1 - \frac{r_c^2}{r^2}\right)^2 \tag{2}$$

where

E = electric potential.

If current is passed radially through the cloud, additional energy must be supplied which would add to the potential of the electrons given by (2). If the anode potential E_a is insufficient to supply the minimum energy at the anode (given by substituting the anode radius r_a into (2)), then the swarm of electrons must be bounded between cathode and anode. In order to calculate effects of the space charge under these conditions, the position of this boundary and the space-charge distribution within should be known. The position of the boundary is readily calculated because the potential and field at the swarm boundary are known. If no electrons are crossing the boundary, the potential at the boundary must be given by (2). The field is, therefore,

$$-\frac{\partial E}{\partial r} = \frac{1}{4}\frac{e}{m} B^2 r \left(\frac{r_c^4}{r^4} - 1\right). \tag{3}$$

By Gauss's theorem the total space charge per unit length within a radius r will be

$$\begin{aligned} \tau &= 2\pi r \epsilon_0 \left(-\frac{\partial E}{\partial r}\right) \\ &= \frac{1}{2}\pi\epsilon_0 \frac{e}{m} B^2 r^2 \left(\frac{r_c^4}{r^4} - 1\right) \end{aligned} \tag{4}$$

where

τ = total space charge per unit length
$\epsilon_0 = (1/36\pi) \times 10^{-9}$ farads per meter.

For a cylindrical diode

$$E_a - E = \frac{-\tau}{2\pi\epsilon_0} \log \frac{r_a}{r} \tag{5}$$

where

E_a = the anode potential
E = potential at some point in charge free space r
τ = charge per unit length inside r.

If we let

$r = r_H$ = boundary of space-charge swarm
$E = E_H$ = potential at r_H from (2)
τ = value defined by (4) for $r = r_H$,

and substitute from (2) and (4) into (5), we have

$$E_a = B^2 \frac{e}{8m} r_H^2 \left[2\left(1 - \frac{r_c^4}{r_H^4}\right) \log \frac{r_a}{r_H} + \left(1 - \frac{r_c^2}{r_H^2}\right)^2\right]. \tag{6}$$

This equation shows us that for a given magnetron, if E_a/B^2 is kept constant, the radius of the space-charge swarm remains constant (under static conditions).

It is important to note that in the derivation of (4) and (6) it was unnecessary to specify the distribution of space charge and potential inside the swarm. It is known that a number of solutions for these distributions are possible in which electrons stream back and forth between the cathode and the outer boundary of the space-charge swarm. Corresponding to each of these double-stream or multiple-stream solutions, as they are called, there would be a different potential and space-charge distribution within the swarm. All of these solutions have been obtained for the plane magnetron.[1] However, for the cylindrical magnetron the complete solution is not yet available. If it assumed that the solution is not multiple stream (i.e., that all of the electrons in the swarm are traveling in circles around the cathode), the resulting space-charge distribution is

[1] J. C. Slater, "Microwave Electronics," D. Van Nostrand Co., New York, N. Y., p. 336; 1950.

$$\rho = -\frac{1}{2}\epsilon_0 \frac{e}{m} B^2\left(1+\frac{r_c^4}{r^4}\right). \quad (7)$$

This is obtained by applying Poisson's equation to (3), and therefore corresponds to minimum energy in the electrons. This distribution will be used in the following discussion.

Propagation of the Electromagnetic Wave in the Magnetron Space Charge

The radio-frequency properties of the space charge have been analyzed previously in two important articles.[2,3] However, many points of particular interest to the problem of frequency characteristics have not been emphasized. In order to establish the relationship of the following treatment to the two previous treatments, the major differences will be pointed out. All three methods are alike in that the space-charge distribution given by (7) is the starting point, and, as was pointed out in the last section, there is no ambiguity in the use of (6) to determine the boundary of the space-charge swarm.

The fundamental equation of motion of an electron in space, in vector form, is

$$\frac{\vec{dv}}{dt} = -\frac{e}{m}(\vec{F} + \vec{v} \times \vec{B}) \quad (8)$$

where

$\vec{v}$ = velocity of the electron
$\vec{F}$ = electric field
$\vec{B}$ = magnetic field.

It is assumed that

$$\vec{v} = \vec{v}_0 + \vec{v}_1$$

$$\vec{F} = \vec{F}_0 + \vec{F}_1$$

$$\vec{B} = \vec{B}_0 + \vec{B}_1$$

where $\vec{B}_0$, $\vec{v}_0$, and $\vec{F}_0$ are static values and $\vec{B}_1$, $\vec{v}_1$, and $\vec{F}_1$ are impressed radio-frequency values. Substituting into (8) and keeping the terms involving radio-frequency values, we have

$$\frac{\partial \vec{v}_1}{\partial t} + (\vec{v}_0 \cdot \nabla)\vec{v}_1 + (\vec{v}_1 \cdot \nabla)\vec{v}_0 + (\vec{v}_1 \cdot \nabla)\vec{v}_1 = -\frac{e}{m}(\vec{F}_1 + \vec{v}_1 \times \vec{B}_0 + \vec{v}_0 \times \vec{B}_1) \quad (9)$$

where we are following the motion of a particular electron. The left side is the total derivative $\vec{dv}/dt$ under these conditions. It is generally agreed that the term $\vec{v}_0 \times \vec{B}_1$ is negligible compared to other terms. In the paper by Blewett and Ramo the term $\vec{v}_1 \times \vec{B}_0$ is also neglected. Actually the effect of the magnetic field is quite important, as will be shown in the following, and as was also pointed out by Lamb and Phillips.

In the paper by Lamb and Phillips it was assumed that v_1 was a small perturbation and therefore the term $(\vec{v}_1 \cdot \nabla)\vec{v}_1$ could be neglected. Their results apply particularly to frequencies near the cyclotron frequency

$$\left(f_c = \frac{1}{2\pi}\frac{Be}{m}\right)$$

and are limited to very small sheaths of electrons surrounding the cathode. Damping is treated in a qualitative sense. Their results will be discussed further at the end of this section.

In the present approach, a simplified problem is treated in order to obtain more generally applicable results. These results will indicate an approximate behavior to be expected in a magnetron which seems to check closely enough with experimental observations to justify the method of treatment. It is assumed that the space-charge swarm is moving with a uniform velocity v_0 so that the term $\vec{v}_1 \cdot \nabla\vec{v}_0$ is dropped in (9). Actually

$$v_0 = \omega r = \frac{Be}{2m} r\left(1 - \frac{r_c^2}{r^2}\right),$$

from (1). Also, the wave is assumed to be propagated perpendicular to $\vec{v}_0$ so that the product $\vec{v}_0 \cdot \nabla\vec{v}_1$ vanishes. The force equation under these conditions becomes simply

$$\frac{\partial \vec{v}_1}{\partial t} = -\frac{e}{m}(\vec{F}_1 + \vec{v}_1 \times \vec{B}) \quad (10)$$

where the subscripts "1" only serve to indicate radio-frequency values and will be dropped in the remainder of the discussion.

Ordinarily in treatment of electrodynamics of a moving medium the effect of the motion does not become appreciable until the velocity is an appreciable fraction of the velocity of light. In the case of the magnetron, however, the effect of the motion may become important when the angular velocity of the edge of the swarm approaches synchronism with the angular velocity of the radio-frequency wave in the interaction space. Under these conditions the electrons can contribute energy to the radio-frequency wave and begin to slow down and form spokes extending toward the anode. These spokes assume a certain phase relationship to the radio-frequency wave which changes with plate voltage and affects frequency in a way not covered by the treatment in this section. Thus the results of this section should only be considered valid for

$$\omega \ll \omega_n \quad (11)$$

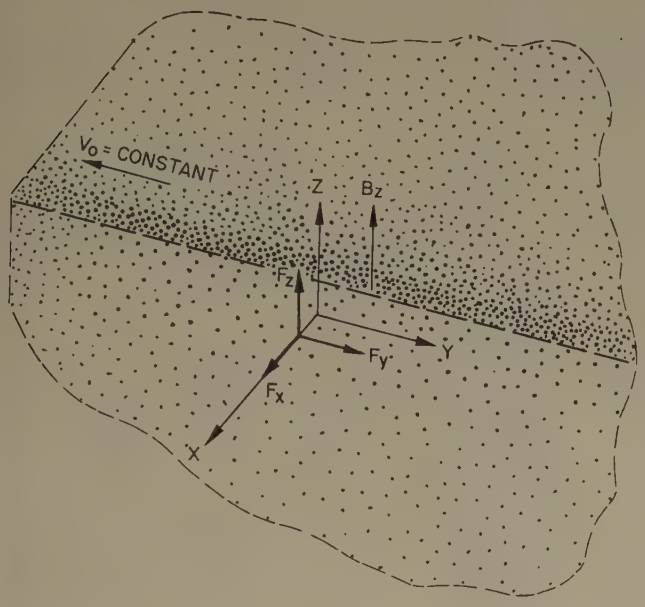
[2] J. P. Blewett and S. Ramo, "High frequency behavior of a space charge rotating in magnetic field," *Phys. Rev.*, vol. 57, pp. 635–641; April, 1940.

[3] W. E. Lamb, Jr., and M. Phillips, "Space charge frequency dependence of magnetron cavity," *Jour. Appl. Phys.*, vol. 18, pp. 230–238; February, 1947.

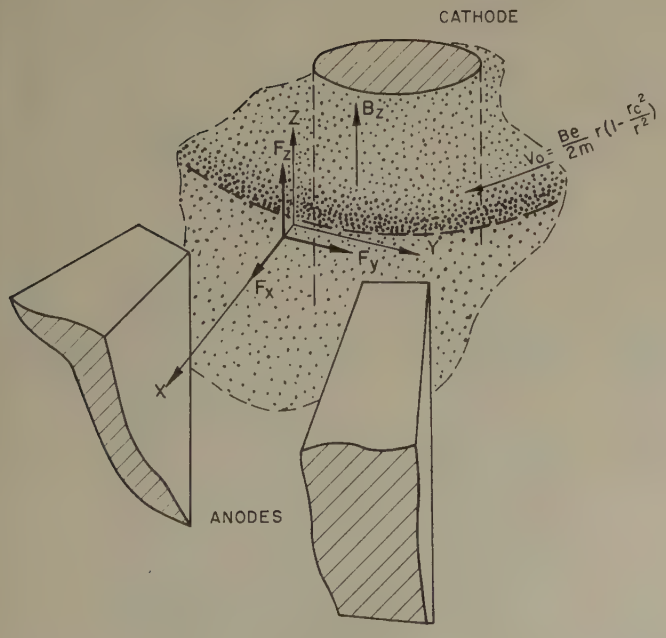
where

$\omega_n = 2\pi f/n$ (synchronous angular velocity)
f = frequency of the radio frequency impressed on the magnetron structure
n = mode number = $\frac{1}{2}$ number of anodes in π mode.

Since we are considering the space charge as an atmosphere of determined density and boundary, it is immaterial what system of co-ordinates is used for the force equation. We are considering properties of space-charge atmosphere as they affect propagation, so it will be simpler to treat a plane wave. The results will then be interpreted in the case of the particular geometry of the magnetron. We will assume first a configuration as shown in Fig. 1(a). Magnetic field is oriented in the z direction; a plane wave is propagated in the x direction. Fig. 1(b) shows, in comparison, the actual case in a magnetron. The force equations and Maxwell's equations yield the following:



(a)



(b)

Fig. 1—(a) Orientation of field vectors assumed for development of equation (22); space-charge swarm moving with uniform velocity. (b) Orientation of field vectors in magnetron space charge.

$$\ddot{x} + \frac{e}{m}F_x + \omega_c\dot{y} = 0 \tag{12}$$

$$\ddot{y} + \frac{e}{m}F_y - \omega_c\dot{x} = 0 \tag{13}$$

$$\ddot{z} + \frac{e}{m}F_z = 0 \tag{14}$$

$$\epsilon_0\frac{\partial F_x}{\partial t} + \rho\dot{x} = 0 \tag{15}$$

$$\frac{\partial H_z}{\partial x} + \epsilon_0\frac{\partial F_y}{\partial t} + \rho\dot{y} = 0 \tag{16}$$

$$\frac{\partial H_y}{\partial x} - \epsilon_0\frac{\partial F_z}{\partial t} - \rho\dot{z} = 0 \tag{17}$$

$$\frac{\partial H_x}{\partial t} = 0 \tag{18}$$

$$\frac{\partial F_y}{\partial x} + \mu_0\frac{\partial H_z}{\partial t} = 0 \tag{19}$$

$$\frac{-\partial F_z}{\partial x} + \mu_0\frac{\partial H_y}{\partial t} = 0 \tag{20}$$

$\omega_c = B\dfrac{e}{m}$ B is z-directed steady magnetic field.

A solution of the type $Ae^{i(kx\pm\omega_f t)}$ is assumed for each of the quantities x, y, z, F_x, F_y, F_z, H_x, H_y, and H_z. ($\omega_f = 2\pi f$). A different constant A, of course, is used in each case. Substituting in (12) through (20) and differentiating, a set of simultaneous equations is obtained. The determinant of the coefficients in these equations is the following

x	y	z	F_x	F_y	F_z	H_y	H_z
$-\omega_f^2$	$\pm i\omega_f\omega_c$	0	e/m	0	0	0	0
$\mp i\omega_f\omega_c$	$-\omega_f^2$	0	0	e/m	0	0	0
0	0	$-\omega_f^2$	0	0	e/m	0	0
$\pm\rho$	0	0	$\pm\epsilon_0$	0	0	0	0
0	$\pm\rho$	0	0	$\pm\epsilon_0$	0	0	$+k/\omega_f$
0	0	$\pm\rho$	0	0	$\pm\epsilon_0$	$-k/\omega_f$	0
0	0	0	0	$+k/\omega_f$	0	0	$\pm\mu_0$
0	0	0	0	0	$-k/\omega_f$	$\pm\mu_0$	0

By Cramer's rule, in order for a solution other than a trivial solution to exist this determinant must be identically equal to zero.[4] It is convenient to solve for $k^2/\epsilon_0\mu_0\omega_f^2 = c^2/v^2$ where c = velocity of light and v = phase velocity of the wave. c/v is the effective index of refrac-

[4] See any advanced calculus text for discussion of this rule.

tion of the medium and c^2/v^2 therefore the effective relative dielectric constant ϵ_r. The result is

$$\epsilon_r = 1 + \frac{\rho e}{\epsilon_0 m} \frac{\left(\omega_f^2 + \frac{\rho}{\omega_0}\frac{e}{m}\right) - 1/2\omega_c^2(1 \mp 1)}{\omega_f^2\left(\omega_f^2 - \omega_c^2 + \rho\frac{e}{m}\right)}. \quad (21)^5$$

From (7) the space-charge density in a magnetron at the boundary of a swarm of radius r is

$$\frac{\rho e}{\epsilon_0 m} = -1/2\omega_c^2\left[1 + \left(\frac{r_c}{r}\right)^4\right] \quad (7a)$$

Letting

$$1 + \left(\frac{r_c}{r}\right)^4 = M,$$

the complete result for effective dielectric constant of the magnetron-type space charge may be written

$$\epsilon_r = 1 - \frac{M}{2}\frac{\omega_c^2}{\omega_f^2}\frac{\omega_f^2 - 1/2(M + 1 \mp 1)\omega_c^2}{\omega_f^2 - \omega_c^2\left(1 + \frac{M}{2}\right)}. \quad (22)$$

For the $(-)$ sign

$$\epsilon_r = 1 - \frac{M}{2}\frac{\omega_c^2}{\omega_f^2}\frac{\frac{\omega_f^2}{\omega_c^2} - \frac{M}{2}}{\frac{\omega_f^2}{\omega_c^2} - \left(1 + \frac{M}{2}\right)}. \quad (23)$$

For the $(+)$ sign

$$\epsilon_r = 1 - \frac{M}{2}\frac{\omega_c^2}{\omega_f^2}. \quad (24)$$

The result of (24) is exactly the same as the result which is obtained when no steady magnetic field is assumed present and is the result obtained in the paper by Blewett and Ramo, due to the neglect of the cross product of the radio-frequency velocity and the static magnetic field in the force equation.

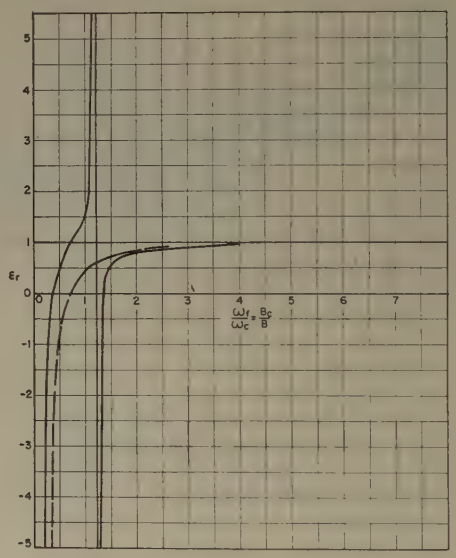
Another case should be mentioned, which, although it does not occur in the conventional magnetron, is of importance in some structures which use the magnetron-type space charge to vary reactance for electronic frequency modulation. In this case the direction of wave propagation is assumed parallel to the direction of the magnetic field. This case is treated by the same method as the one just treated with the result

$$\epsilon_r = 1 - \frac{M}{2}\frac{\omega_c}{\omega_f}\frac{1}{\frac{\omega_f}{\omega_c} \pm 1}. \quad (25)^6$$

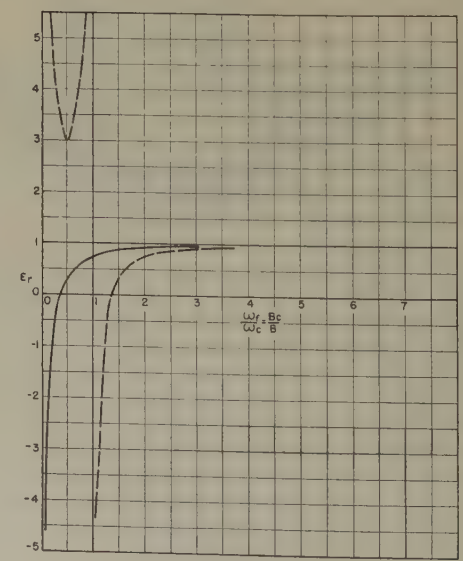
Equations (22) and (25) are plotted in Figs. 2(a) and 2(b) with the assumption that $M=1$. This is approximately true only for values of r_c/r less than 1/3. The curves as plotted will, however, represent the picture with sufficient accuracy to support discussion.

The meaning of each of the various values of effective dielectric constant is not obvious from the development presented here. However, further examination of the polarizations of the waves and of a physical picture show the following to be true.

In Fig. 2(a) the solid curve from (23) corresponds to an electromagnetic wave polarized with the E vector perpendicular to the static magnetic field. The wave cannot be entirely transverse because there must be a component of E in the direction of propagation. The actual situation in an ideal multianode magnetron



(a)



(b)

Fig. 2—Dielectric constant of magnetron space charge as function of $\omega_f/\omega_c = B_c/B$. (a) Direction of propagation transverse to direction of magnetic field. (b) Direction of propagation same as direction of magnetic field.

[5] It should be noted that the $(\pm)$ sign in this result is not a result of the assumption of a $(\pm)$ sign in the assumed solution but results from the quadratic nature of the solution of the determinant.

[6] In this case the $(\pm)$ sign is a result of the assumption that it exists in the exponential solution.

should be approximated by this case as examination of Fig. 1(b) will show. If end effects are neglected, the electric fields are entirely in the xy plane perpendicular to the static magnetic field. However, propagation is not always perpendicular to $\vec{v_0}$.

In Fig. 2(a) the dotted curve from (24) corresponds to an electromagnetic wave polarized with the E vector parallel to the static magnetic field. In this case the presence of the magnetic field does not have any effect, as was pointed out previously.

In Fig. 2(b) the solid curve from (25) with + sign corresponds to an electromagnetic wave with left-hand circular polarization.

In Fig. 2(b) the dotted curve from (25) with − sign corresponds to an electromagnetic wave with right-hand circular polarization.

The effective dielectric constant, which is really a measure of phase velocity of the wave, depends on polarization, relationship of direction of propagation to direction of magnetic field, and value of ω_f/ω_c. The properties of these regions and the effect to be expected in a magnetron-type structure may be summarized as follows:

$\epsilon_r<0$. In this case the phase velocity is imaginary; a wave will not propagate within the space charge; therefore, a space-charge boundary acts as a reflecting surface. The capacitance between cathode and anodes is increased by the presence of the space charge.

$0<\epsilon_r<1$. In this case the phase velocity of the wave exceeds the velocity of light. The capacitance between cathode and anodes is decreased by the presence of space charge.

$\epsilon_r>1$. In this case the phase velocity of the wave is less than the velocity of light. The capacitance between cathode and anodes is increased by the presence of the space charge.

The total range of values covered by the graphs of Fig. 2 represents a considerable variation of conditions which might be imposed on the magnetron-type structure. Data exist only in limited regions; some of this will be presented in the next section.

It will be interesting at this point to compare these results with the results of Lamb and Phillips. In their paper the behavior near the cyclotron resonance is described from an impedance point of view for very small sheaths of electrons surrounding the cathode. This result is the following:

$$Z_{e1} \cong \frac{F_\theta}{H} = \frac{in^2 s}{r_c^2 \epsilon_0 \omega_f} \frac{\omega_f^2}{\omega_c^2 - \omega_f^2} \tag{26}$$

where

F_θ/H = the ratio of the electric field vector to the magnetic field vector

s = thickness of the electron sheath around the cathode.

It is assumed that

$$\frac{ns}{r_c} < \frac{\omega_c^2 - \omega_f^2}{\omega_f^2} \quad \text{and} \quad n \neq 0.$$

This restriction on the magnitude of s/r_c is a severe limitation in the practical case of an oscillating magnetron or frequency-modulation structure. In either of these cases, s/r_c can be an appreciable fraction of r_a/r_c. An effective cathode radius may be calculated which, when used as a boundary condition, obtains the same effect on resonant frequency of the anode block as the condition of (26). Thus

$$r_{ceff} = r_c\left(1 + \frac{2ns}{r_c} \frac{\omega_f^2}{\omega_c^2 - \omega_f^2}\right)\frac{n}{2}. \tag{27}$$

This result predicts a resonance at the cyclotron frequency which is qualitatively described by a positive wavelength shift (capacitance increase) for $\omega_f/\omega_c<1$ and a negative wavelength shift (capacitance decrease) for $\omega_f/\omega_c>1$. This effect and the type of effects predicted by (23) might be simultaneously possible in an actual magnetron, since the assumptions involved in neither development can be held except in extreme cases. A qualitative picture of the behavior of the electrons near the cyclotron resonance is given in Fig. 3. In all cases the angular frequency impressed on the anode is assumed to be the cyclotron frequency. ω is the angular velocity of the outermost electrons. If

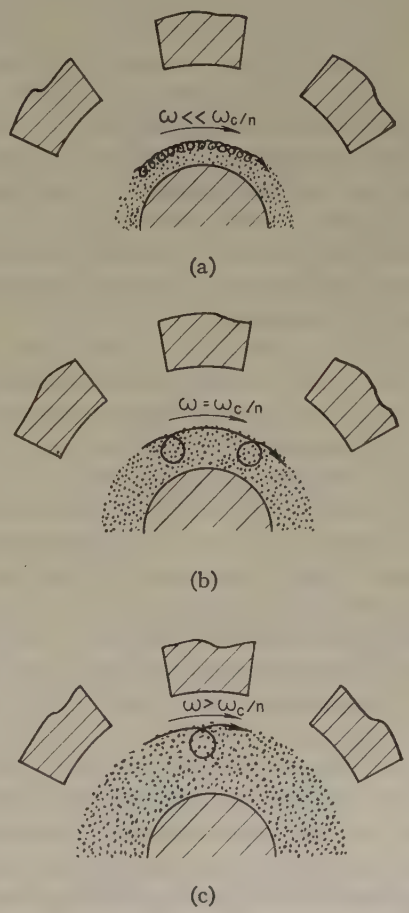


Fig. 3—Qualitative picture of cyclotron resonance.

$\omega \ll \omega_c/n$ (corresponding to small s), as in Fig. 3(a), the perturbed electron will execute several cycles in passing a set of anodes. In this case the resonance effect should occur very near the cyclotron frequency. The effect of the steady-state angular velocity is not important. If $\omega = \omega_c/n$, as in Fig. 3(b), the electron executes a single cycle in just the time it takes it to move, due to the steady-state velocity, from one set of anodes to the next. In the same time, the direction of the field between the next set of anodes has changed to be in phase with the electron oscillation. In the case of Fig. 3(c), the electron does not execute a single cycle in transit between two anodes and arrives between the next set out of phase with the field. Essentially these observations mean that the magnetic field for the cyclotron resonance should be a function of voltage. This has been observed experimentally and is presented in Fig. 10. To our knowledge more extensive data on the cyclotron resonance which might serve to clarify the picture do not exist.

Space Charge and the Equivalent Circuit

The details of an equivalent circuit for a microwave device such as a magnetron naturally change with the structure of the magnetron. Effects of end hats, straps supporting structures, and the like may or may not be important enough to be included in the circuit. The equivalent circuit is usually based on the assumption that the various possible modes of oscillation are sufficiently separated in frequency to be considered individually. This permits the representation of the resonant circuit of the magnetron as a simple parallel resonant circuit. When this assumption is not valid, the resonance is made complex and, in general, must be treated as a special case. However, if the assumption is not justified, some sort of device is usually necessary to induce mode separation before the magnetron is practically usable. Thus, in most practical cases the simplified approach is adequate.

The most important concept in connection with equivalent circuits of magnetrons relative to the present problem is the concept of electron-transit admittance. It is the susceptive portion of this admittance which affects frequency characteristics of the magnetron. If an equivalent circuit may be established in which the function of the electron-transit susceptance is properly understood, the picture is greatly simplified. This has been done with satisfactory results for triodes, tetrodes and klystrons, but the picture in the case of magnetrons is still obscure. The circuit in Fig. 4(a) is suggested as equivalent in the case of a nonoscillating magnetron. In this circuit, the electron-transit admittance is represented by y_e which may be defined as the admittance of the electrons as seen from terminals representing the two sets of anodes. The nature of this admittance changes for various conditions of anode voltage, magnetic field, and radio-frequency voltage between anode segments. The primary purpose of this paper is to present the over-all picture of these changes. The picture for an oscillating magnetron is more complex. However, a convenient picture is obtained by replacing the admittance y_e by a current generator $i_g = y_e e_T$ (see Fig. 4(b)). The admittance y_e may now be thought of as the equivalent admittance of a current generator. The value of this admittance is a function of plate current and loading. Variation in the susceptive portion of this admittance with current is the cause of frequency pushing. This will be discussed in a following section.

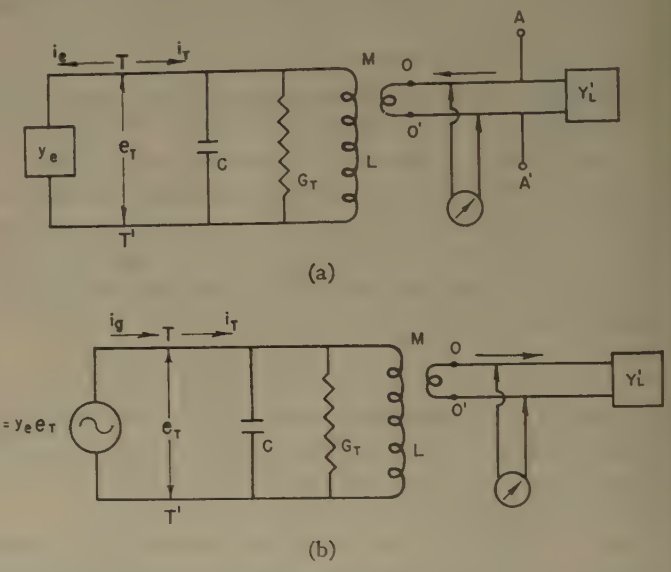


Fig. 4—Equivalent circuits; arrow indicates direction of power flow. (a) Equivalent circuit for nonoscillating magnetron. (b) Equivalent circuit for oscillating magnetron.

Experimental investigation of the nature of the quantity y_e must be made by a meter located in the line between the output terminals O and O' and the load Y_L. In the case of the nonoscillating magnetron (Fig. 4(a)) an external signal must be fed into the circuit at the points A and A'. Measurements of standing-wave ratio and position of minimum, coupled with a knowledge of properties of the circuit and the controllable parameters in the circuit, yield an experimental result for y_e as a function of the variable parameters. This type of measurement we call a hot impedance test, in analogy with the established term, cold impedance test. When anode voltage is increased to the point of supporting oscillation, these measurements can no longer be made and the circuit in Fig. 4(b) applies. Standing-wave ratio and position of the minimum measurements now apply to the load. No external source is present. The load is therefore used as a variable and the effect on resonant wavelength, power output, and the like is recorded in the Rieke diagram. Variation of frequency with the plate current (frequency pushing) can be measured quite simply in connection with over-all performance data taken for constant loading.

In the case of the nonoscillating tube, a radio-frequency voltage may be considered applied across the

capacitive portion of the magnetron circuit, at the boundary between the resonant circuit structure and the interaction space. This is represented by T–T' in Fig. 4(a). The radio-frequency voltage causes a current i_T to flow into the tank circuit. If there are electrons present in the interaction space they may be represented by an admittance y_e through which a current i_e will flow. The currents i_e and i_T are independent of each other if the radio-frequency voltage is assumed unaffected by their magnitudes. If the admittance of the tank circuit is known, the admittance y_e could presumably be measured. This admittance should be dependent upon the values of magnetic field, anode voltage, radio-frequency voltage, and geometry of the interaction space.

In the case of the oscillating magnetron as represented in Fig. 4(b), the current i_T, developed in the tank circuit, is induced by spokes of synchronous space charge rotating in the interaction space. This current results in a radio-frequency voltage at the terminals T–T'. The current cannot exist until the oscillations become regenerative. The synchronous space-charge spokes cannot exist until radio-frequency voltages are present, i.e., until oscillation starts. The rotating spokes of synchronous space charge may be thought of as a current generator. There is a phase difference between the generated current and the radio-frequency voltage which causes the oscillations to build up at a lower frequency than the natural resonance frequency of the tank circuit. This phase difference and the equivalent negative conductance of the electrons are represented in y_e, the admittance equivalent to the generator representing the electrons. The value of this admittance must be such that the net susceptance and conductance of the circuit are cancelled at the frequency of oscillation. When the admittance characteristic of the tank circuit is known as a function of frequency near resonance, the value of y_e can be calculated.

These two interpretations of y_e should be kept in mind while reading the following sections. We will find that in the first case for the nonoscillating magnetron, the space-charge effects on frequency are primarily a function of the dimensions and density of the hub of the space-charge wheel. (See Fig. 13 for pictorial representation of the space charge.) In the second case of the oscillating magnetron, the effect on frequency is due to the phase relation of the spokes of synchronous space charge to the radio-frequency voltage. The two effects may cause frequency shifts in opposite directions. Quantitative agreement between experiment and theory for the first case is shown in the Appendix. In the second case, only qualitative discussion is thus far possible.

Space-Charge Effects in the Nonoscillating Magnetron

In order to measure effects of space charge in the nonoscillating magnetron, hot impedance measurements must be made from the output terminals. The measurements which have been taken are of four types as follows:

1. Impedance measurements at constant magnetic field and radio-frequency voltage, anode potential as variable parameter.
2. Impedance measurements at constant magnetic field and anode potential, radio-frequency voltage as variable parameter.
3. Resonant wavelength measurements at low radio-frequency voltage for different magnetic fields, anode potential as variable parameter.
4. Resonant wavelength measurements at low radio-frequency voltage and constant space-charge swarm radius, magnetic field as variable parameter.

A schematic drawing of the experimental setup is shown in Fig. 5. In order to obtain high radio-frequency voltage, one magnetron is used to drive another. Radio-frequency voltage is varied by means of attenuating reflectors placed in a slotted section between

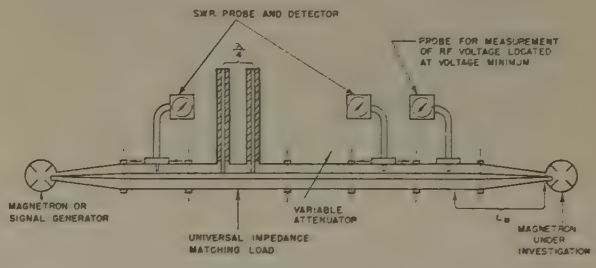

SWR PROBE AND DETECTOR
PROBE FOR MEASUREMENT OF RF VOLTAGE LOCATED AT VOLTAGE MINIMUM
MAGNETRON OR SIGNAL GENERATOR
VARIABLE ATTENUATOR
UNIVERSAL IMPEDANCE MATCHING LOAD
MAGNETRON UNDER INVESTIGATION

Fig. 5—Experimental apparatus for hot impedance heating.

the impedance matching load and the magnetron under investigation. Radio-frequency voltage is measured by a probe placed at a voltage minimum (at cold resonance) approximately three wavelengths from the magnetron coupling loop (L_M in the diagram). This probe leads to a crystal detector and microammeter. The probe is calibrated against power measurements into a matched load and radio-frequency voltage calculated from the known line impedance of 52 ohms. The impedance matching load is quite useful for measurements of this type or in any application where a high-Q circuit is to be driven by a magnetron. It consists of two loads separated by $\lambda/4$. The driving magnetron is thus under no circumstances subject to standing-wave ratios greater than three to one.

In the impedance measurements, Q_0, λ_0 and G_0 are measured and plotted against the variable parameter, Q_0 is the unloaded Q of the magnetron, λ_0 is the resonant wavelength, and G_0 is the input conductance at resonance. $G_0 = Y_0/\sigma_0$, where σ_0 is the minimum standing-wave ratio and Y_0 is the characteristic admittance of the line

The results of hot impedance measurements made under various conditions are shown in Figs. 6 through 12. The results shown in Fig. 6 offer a comparison between frequency effects in the nonoscillating magnetron and in the oscillating magnetron. The increasing reso-

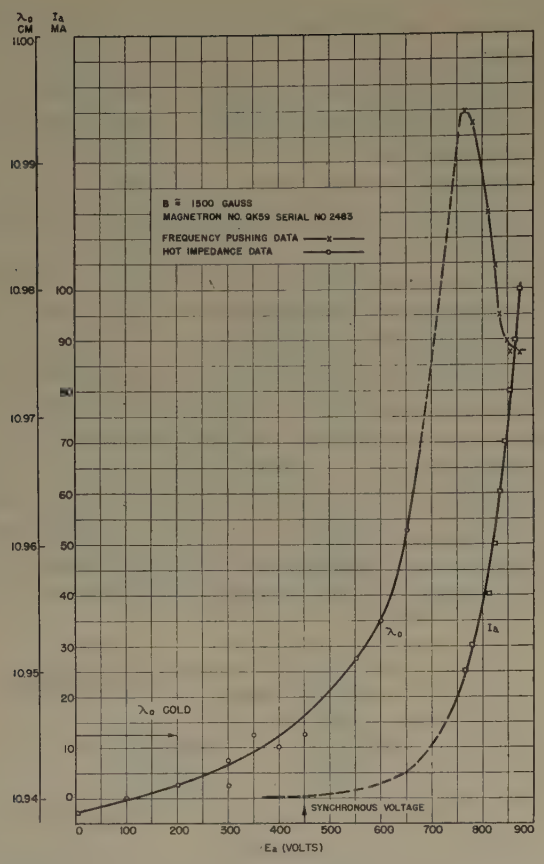
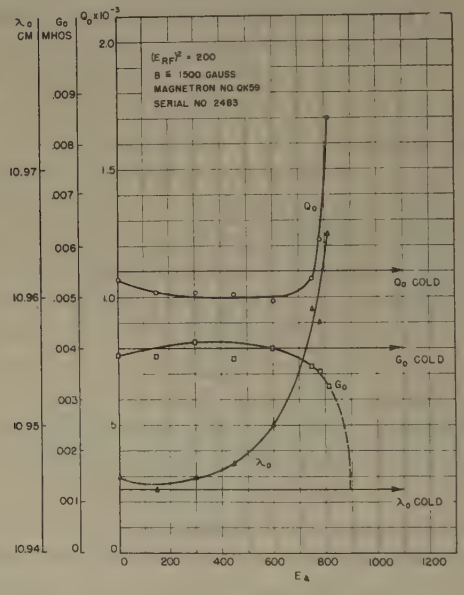


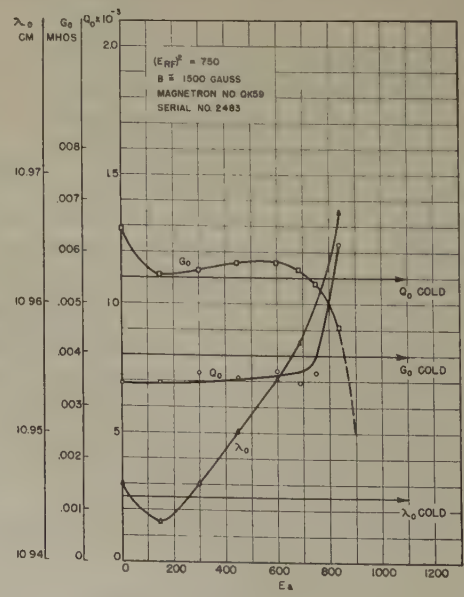
Fig. 6—Change of magnetron resonant wavelength with plate voltage. Comparison of frequency pushing and hot impedance test results.

nant wavelength up to the voltage for which synchronism begins (450 volts) is due to the capacitance between anodes increasing as a cloud of electrons of negative dielectric constant expands within the anode structure. This is what may be called a passive effect of the electrons. Above this point synchronous reactance causes a sharp rise in wavelength, and when oscillation starts the direction of wavelength shift reverses. The original cold resonant wavelength is not reached. This reversal effect is called frequency pushing, and may be called an active effect of the electrons. Frequency pushing and synchronous reactance will be discussed qualitatively in the next section. The passive effects in the preoscillating region can be discussed more quantitatively. This is done in the Appendix in terms of the data on tubes built in the Michigan laboratory.

In Fig. 7 the variation of λ_0, Q_0 and G_0 is plotted against plate voltage for two values of radio-frequency voltage impressed upon the anode structure. The general form of the curves is seen to be the same, with a reduction in Q as the radio-frequency voltage is raised. The Q_0 curves are relatively flat up to about 700 volts. This indicates that there is no change in the conductive characteristics of the space charge in this region. At about 700 volts, the Q_0 begins to rise sharply. At the point of oscillation it would, ideally, go to infinity as the conductance goes to zero. This point occurs at about 900 volts. This behavior means that in the region between 700 and 900 volts space charge is contributing energy to the radio-frequency field and therefore synchronous bunches of space charge have been formed. When the Q_0 curve intersects with the cold Q_0 line the space charge is contributing just enough negative conductance to compensate for losses which may be present within the space charge due to bombardment of the cathode and collisions with large ions. The further increase in Q_0 represents compensation for copper losses in the resonant circuit. The reduction of the Q_0 in the flat portion of the curve is due to increase in losses due to back bombardment as radio-frequency voltage is raised. The data in Fig. 8 show how the Q_0 varies with radio-frequency voltage for a value of anode voltage in the flat portion of the curve of Fig. 7. The losses are



(a)



(b)

Fig. 7—Q_0, λ_0, and G_0 of hot magnetron as a function of plate voltage for various radio-frequency voltages.

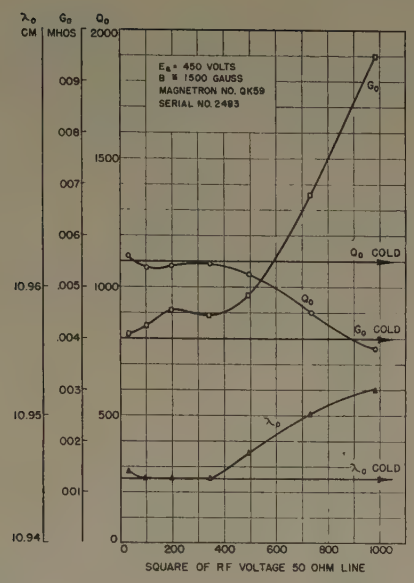


Fig. 8—Q_0, λ_0, and G_0 of hot magnetron as function of radio-frequency voltage for constant plate voltage.

going up rather rapidly with the increasing radio-frequency voltage. This is probably due to an increase in the energy spent in back bombardment of the cathode.

The complexity of the space-charge frequency characteristics in the nonoscillating magnetron when a wide range of variables is considered is clearly illustrated by the four sets of data in Fig. 9. These data were taken by an absorption method in which resonance was observed on an oscilloscope pattern. Q measurements could not be made. The radio-frequency voltage was supplied from a klystron signal source. The curves are similar to those just discussed except that E/B^2 is used as the independent variable. The radius of the space-charge swarm, in the absence of radio frequency, is proportional to this quantity. In the presence of radio frequency there are three critical conditions involving magnetic field and voltage; these are expressed by (28), (29), and (30) which follow. The critical values are noted on the curves of Fig. 9.

$$\omega_c \cong \frac{B_c e}{m} \tag{28}$$

where

$$\omega_c = \frac{2\pi c}{\lambda_c}$$

c = velocity of light.

This equation defines the cyclotron resonance. λ_c is the critical wavelength for the particular magnetic field B_c at which the period of natural rotation of an individual electron in the magnetic field is equal to the period of the radio-frequency cycle. As was pointed out in the discussion of Fig. 3 the resonance in the magnetron space charge should also be a function of voltage. This is borne out in the results shown in Figs. 9(b)

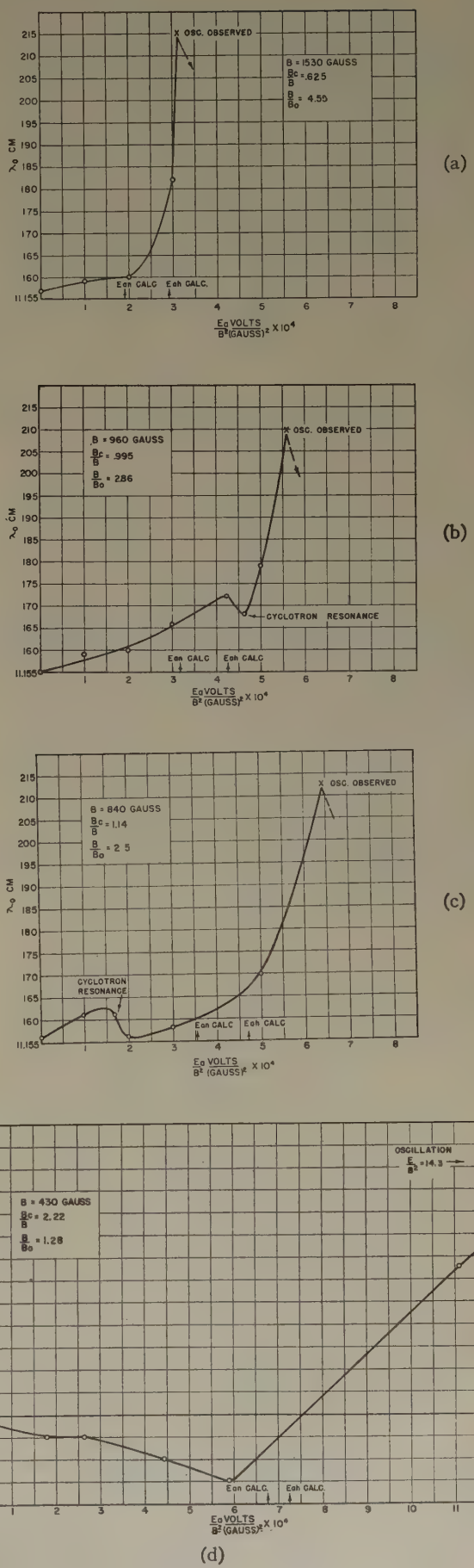


Fig. 9—Hot impedance test on QK59 no. 2483.

and 9(c) where the cyclotron resonance shows up as a perturbation of the resonant wavelength for two different voltages at slightly different magnetic fields.

$$\frac{E_{an}}{E_0} = \frac{B_n}{B_0} \frac{r_c^2/r_a^2}{\frac{B_n}{B_0} - \left(1 - \frac{r_c^2}{r_a^2}\right)} \left[2\left(\frac{B_n}{B_0} \frac{2}{1 - \frac{r_c^2}{r_a^2}} - 1 \right) \log \frac{\sqrt{\frac{B_n}{B_0} - \left(1 - \frac{r_c^2}{r_a^2}\right)}}{\frac{r_c}{r_a}\sqrt{\frac{B_n}{B_0}}} + 1 \right] \tag{29}$$

where

$$E_0 = \frac{m}{2e} \omega_n^2 r_a^2$$

$$B_0 = \frac{2m}{c} \omega_n \frac{1}{(1 - r_c^2/r_a^2)}$$

(ω_n defined in (11)).

Equation (29) relates the anode voltage (E_{an}) and magnetic field (B_n) for which outer electrons in the space-charge swarm reach a velocity synchronous with the angular velocity of the radio-frequency wave traveling around the interaction space. For higher voltages than E_{an} the electrons are trying to move faster than synchronism and can give energy to the radio-frequency field. This condition shows up as a contribution of negative conductance and positive susceptance to the system, thus causing a rather sharp increase in Q and resonant wavelength.

$$\frac{E_{ah}}{E_0} = 2\frac{B}{B_0} - 1. \tag{30}$$

This equation defines the anode voltage at which synchronous electrons can reach the anode with no radially directed velocities (Hartree voltage). This voltage is approximately the voltage at which oscillations begin.

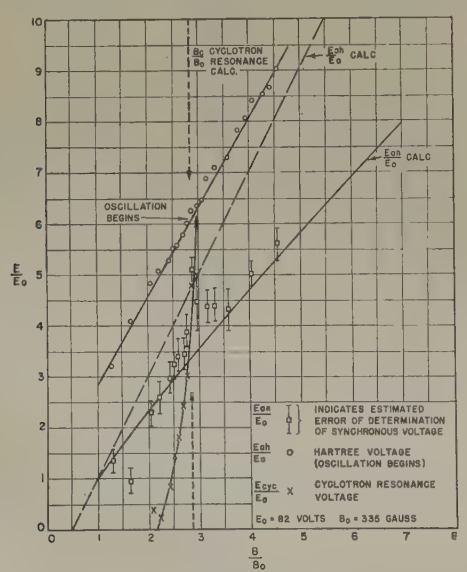


Fig. 10—Summary data on QK59 no. 2483 illustrating equations (28), (29), and (30).

Fig. 10 presents summary data of these three conditions extracted from a group of 26 curves similar to those of Fig. 9. The calculated values are presented for comparison. A considerable spread is represented for points on the curve for E_{an}/E_0, since the point at which a sudden increase in resonant wavelength occurs on the experimental curves is not definite.

The observed starting voltage seems to bear a definite relation to the calculated Hartree voltage, since the slopes of the two curves are approximately the same. The difference is probably due to the effect of the load on the starting voltage. This has not been quantitatively analyzed, but it may be said that, in a given magnetron, as the Q is lowered the starting voltage is raised.

The critical magnetic field for the cyclotron resonance is quite obviously affected by voltage. No satisfactory theory has been developed to give quantitative explanation of this effect. The synchronous voltage checks very well, considering the region of doubt which exists in its determination. It seems to be strongly perturbed in the region of the cyclotron resonance. It is interesting to note, however, that the cyclotron resonance seems to have no particular effect on the starting voltage for oscillation.

The static cutoff voltage (given by (2) with $r = r_a$) is calculated to be $E/B^2 = 7.4$. It is quite obvious in Fig. 9(d) and several other sets of data which are not given that this is not checked for low magnetic field in this particular magnetron.

In order to observe effects on resonant frequency due only to the change in effective dielectric constant of the space-charge swarm (as given by (23)), it is necessary to use data taken at various magnetic fields and at constant swarm radius. It is also necessary to stay below the voltage required to produce synchronous electrons. Thus, data in the curves of Fig. 9 taken below the synchronous voltage should represent the effect due to to the expansion of a space-charge swarm having an effective dielectric constant determined by $B_c/B = \omega_f/\omega_c$. Wavelength shift for four values of E/B^2 and varying B is plotted in Fig. 11. The position of the observed cyclotron resonance and the calculated field required for synchronism are marked. The latter is given by

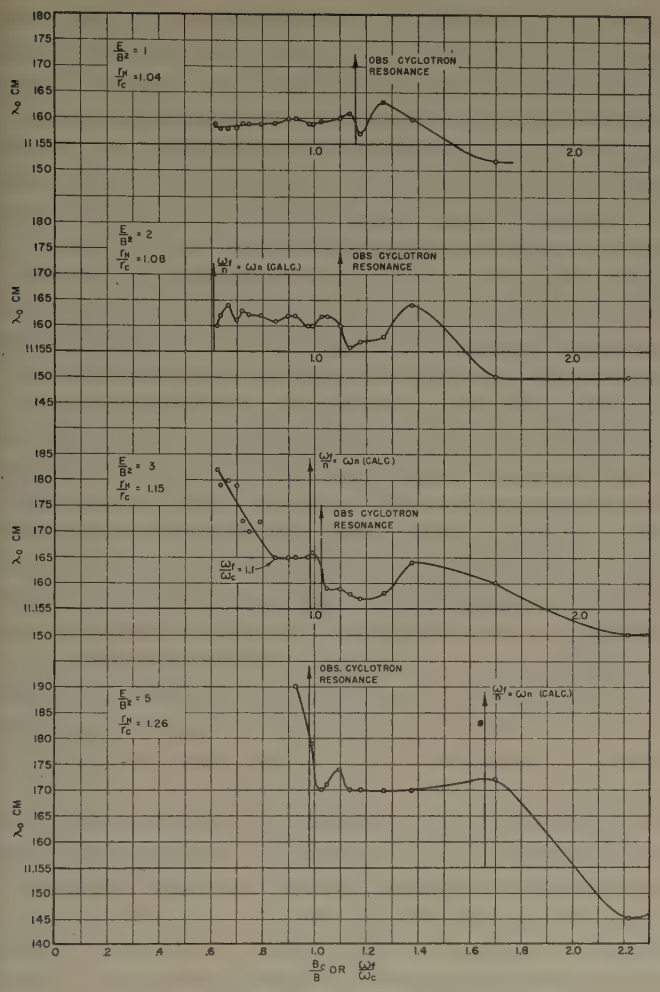


Fig. 11—Hot impedance test on QK59 no. 2483.

$$\frac{B_n}{B_0} = \frac{1 - \dfrac{r_c^2}{r_a^2}}{1 - \dfrac{r_c^2}{r_n^2}}. \tag{31}$$

For $\omega_f/\omega_c < \omega_f/n\omega_n$ the outer electrons in the swarm are tending to travel with greater than synchronous velocities and can contribute synchronous reactance which masks the effect of changing dielectric constant. The curve for $E/B^2=2$, $r_H/r_c=1.08$ is replotted in Fig. 12 with the effective dielectric constant as given by (23). The expected wavelength shift (with amplitude arbitrarily adjusted to equal the observed shift) is shown by the dotted line. Agreement seems to be good except in the region between $\omega_f/\omega_c=0.575$ and the observed cyclotron resonance. This may be due to the fact that the electrons are approaching synchronous velocities.

The over-all qualitative picture presented by these data is fairly clear, while attention to particular points may be misleading because of experimental inaccuracies or insufficient theoretical understanding. Some of the important conclusions are summarized below, and quantitative results for some particular cases are given in the Appendix.

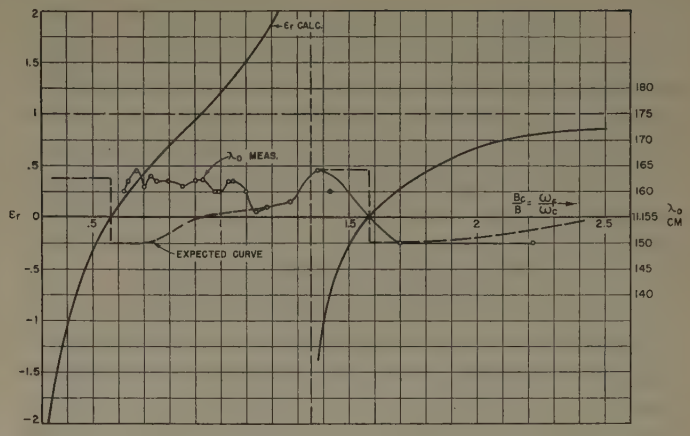


Fig. 12—Effective dielectric constant for magnetron space charge compared with wavelength shift for $r_H/r_c=1.08$.

The three types of effects on frequency are clearly represented by the data.

1. Passive effects due to wave-propagating properties are illustrated as wavelength shift at subsynchronous voltages in Fig. 9 and to the right of the lines $\omega_f/n=\omega_n$ in Fig. 11. The subsynchronous data in Fig. 9(a) illustrate increasing wavelength for $\epsilon_r<0$ and in Fig. 9(d) decreasing wavelength for $0<\epsilon_r<1$. The curves in Fig. 12 which pertain to these effects have been discussed in the last paragraph.

2. Synchronous reactance is demonstrated by the relatively sharp increase in wavelength above synchronous voltage and to the left of the line $\omega_f/n=\omega_n$ in Fig. 11. The case for $E/B^2=5$ is particularly interesting in this connection. The decrease in wavelength showing up in the other curves between $B_c/B=1.05$ and $B_c/B=1.35$ is apparently cancelled by the effects of synchronism. This shows up even more clearly upon careful examination of data of the type shown in Fig. 9 from which this curve was taken. Synchronous reactance will be discussed more completely in the next section.

3. The cyclotron resonance shows up quite obviously in Figs. 9(b), and 9(c), and is, as would be expected, dependent upon anode voltage. It is not clear from the data whether this point is intimately related to the other two effects. It does appear in Fig. 11 that a sharp increase in wavelength with increasing magnetic field should be associated with the cyclotron resonance.

The most probable sources of error are the following:

Magnetic field for the entire series of measurements may be off by 75 to 100 gauss. It is fairly certain that the calibration was not changed during the series of measurements, because it was possible to recheck critical points at the cyclotron resonance and starting voltage.

Dimensions of the magnetron, particularly r_a/r_c, may be in error by 10 to 20 per cent. Another tube which was taken apart had a cathode larger in this proportion. The dimensions used were taken from data in the tube specifications.

Wavelength measurements were made with a Mico wavemeter. The estimated error is ± 0.002 cm. The direction of wavelength shift could always be observed by watching the oscilloscope screen. Determination of the exact resonant wavelength near the cyclotron resonance was difficult because of the distortion of the scope pattern.

Space-Charge Effects in the Oscillating Magnetron

Evidence of space-charge effects in the oscillating magnetron is given in the results of frequency-pushing measurements and in Rieke diagrams. Space-charge effects on frequency in the conventional oscillating tube are of small magnitude, of the order of 1 per cent. Frequency pushing is ordinarily defined as variation of oscillatory frequency with plate current, in contrast with the term frequency pulling, which is, ideally, variation of frequency at constant standing-wave ratio in the Rieke diagram.

More generally it is convenient to think of frequency variation over a performance chart (set of volt ampere characteristics at varying magnetic fields and constant load) and frequency variation with variation in load impedance at constant current and magnetic field as is experienced in the Rieke diagram. Variation of frequency over the performance chart is entirely due to space-charge effects. Variation of frequency in the Rieke diagram is primarily due to changes in the susceptive portion of the load impedance. However, contours of constant frequency in the Rieke load-impedance diagram should follow contours of constant susceptance. The fact that this is not the case may be attributed to space-charge effects.

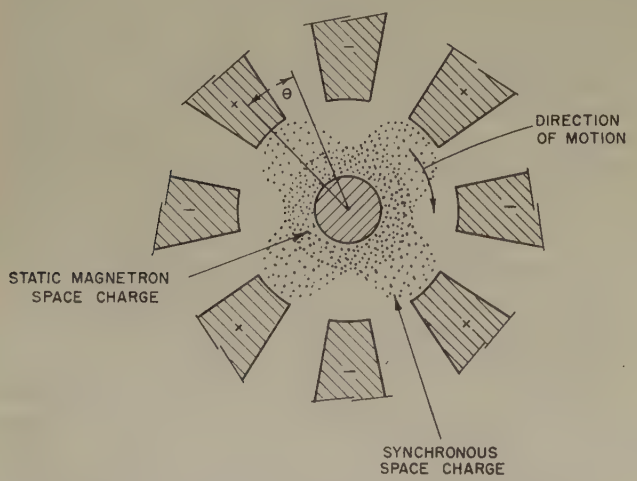


Fig. 13—Pictorial representation of space charge within interaction space.

Fig. 13 presents a qualitative picture of the space-charge swarm with spokes at an instant when the anodes are at their maximum + or − radio-frequency potential. The spokes form on the static magnetron space-charge swarm bounded by the synchronous radius (which can be calculated from (31)). In the nonoscillating magnetron with imposed radio-frequency, as described in the last section, the spokes can form without reaching all the way out to the anode. The maximum radius reached in the spoke is determined by the anode potential, and the spoke will form in the region of the maximum positive potential, 90 electrical degrees ahead of the maximum decelerating field. Thus the current induced by the rotating spokes will lead the radio-frequency voltage by approximately 90 degrees. As the anode potential is increased the spoke will extend farther toward the anode, maintaining the same phase position but increasing the amount of susceptance contributed by the space charge. This accounts for the sharp rise in resonant wavelength before oscillation starts, exhibited in the curves of Figs. 6 through 9. When oscillation starts, the spokes must reach out of the anodes and there is a transport of electrons through the spokes sufficient to supply the dc anode current necessary to provide input power. The generated frequency is usually lower than the frequency of the tank circuit by a margin of the order of $1/Q$. The impedance of the tank circuit is almost a pure inductance and the power delivered from the electron swarm is small. In order for more power to be delivered from the spokes to the circuit the angle θ must be reduced so that the induced current leads the voltage less than 90 degrees. As the voltage is raised further, the phase angle is reduced further, thereby decreasing the positive susceptance contributed by the spokes and decreasing the resonant wavelength. Fig. 6 illustrates this effect. The dotted lines in Fig. 9 also indicate the direction of wavelength shift after oscillation was observed.

The fact that the resonant wavelength does not come back to the cold resonance value may be due to the presence of the hub of subsynchronous space charge. It is important to realize that variation in frequency over the performance chart may depend upon the "passive" effects of the hub of the space-charge wheel as well as the "active" effects of the spokes. Therefore, a complete analysis of pushing data would be more complex than the relatively simple interpretation just given.

The difference in the physical significance of the quantity y_e in the preoscillating and oscillating magnetron as discussed in connection with Fig. 4 is apparent in the above discussion. In the former case, expansion of the hub and synchronous spokes have the major effect, with some complication introduced by the cyclotron resonance. In the latter case, the effect of the hub is probably a constant correction, whereas the phasing of the spokes with respect to the radio-frequency wave in the interaction space makes a major contribution.

Space-charge effects in the Rieke diagram are intimately related to frequency pushing. The rotating swarm is thought of as a current generator, the frequency of which is a function of power output. Power output in turn is a function of the load on the generator. The experimental evidence of Rieke diagrams indicates

the electronic susceptance to be a function of the load conductance on the magnetron. Variation of the conductive portion of the magnetron load without change in the susceptive portion varies the form of the resonance curve without changing its position on the frequency axis. The rotating swarm of electrons must adjust itself to meet the conditions of negative conductance and phase relationship to the radio-frequency voltage imposed by the resonant circuit. In addition, the changing radio-frequency voltage caused by variation in load will react on the electron swarm. This combination of causes must have a very complex, but not very large, effect upon the frequency of oscillation. Further complication results from the fact that a particular value of load conductance (a particular form of the resonance curve) allows maximum efficiency of energy transference from the electron swarm to the radio-frequency field. This is the condition of optimum shunt impedance. The characteristics of the optimum condition are understood for conventional oscillators employing triode or tetrode vacuum tubes, but still not satisfactorily explained in the case of the magnetron oscillator.

Conclusions

The present paper is not meant to be a complete and final analysis of the problem of the magnetron space-charge and frequency characteristics. It is intended to relate as many as possible of the known facts and theories in such a way that it can be used as a guide for further research and development. We have presented in some detail the ideas and data originating in the University of Michigan laboratory and have tried to provide enough discussion and criticism of other ideas to make the development consistent.

Some important conclusions have been mentioned in the discussion of the experimental results and theory. These are the following:

1. Frequency pushing with increasing voltage is primarily due to a decrease in wavelength caused by the active phasing effect of the electrons in the spokes of the space-charge wheel acting as a current generator in the magnetron.

2. The increase in the extent of space-charge spokes as voltage is increased under hot impedance test conditions may also contribute an increasing positive susceptance without change in the phase angle of the spoke relative to the wave of radio-frequency potential.

3. Frequency shifts caused by the subsynchronous swarm as voltage is increased under hot impedance test conditions are primarily of two types. In one case, the dielectric constant of the hub of the space-charge wheel is negative and the resonant wavelength increases as the hub expands. In the other case, the dielectric constant of the hub of the space-charge wheel is positive, but less than unity, and the wavelength decreases as the hub expands. These effects may be called passive effects.

4. For a particular value of magnetic field, under hot impedance test conditions, the natural resonance of the individual electrons in the space charge causes perturbation of the resonant wavelength. This is the cyclotron resonance ($\omega_f = \omega_c$).

5. Frequency pulling is primarily an effect of circuitry. Deviations from the values predicted on the basis of circuitry are due to interrelation of the equivalent susceptance and conductance of the space-charge cloud acting as a current generator in the magnetron. They are therefore related to frequency pushing.

It would be desirable to amplify experience by carrying out experiments designed to determine the exact value of y_e, the electronic admittance, under various conditions in both the nonoscillating and the oscillating cases. Possibly, if enough data were available on different magnetrons, generalizations could be made which would give more insight into the actual behavior in the oscillating magnetron. It is important to realize that, although the frequency shifts due to space-charge effects are small compared to the resonance frequency (of the order of one per cent), an understanding of the underlying causes of these shifts is equivalent to an understanding of the basic electronic principles of magnetron operation.

Frequency shifts of the type mentioned in 3 and 4 above may be used in a reactance tube to produce frequency modulation. The problem of designing a tube of this type has been undertaken in the University of Michigan laboratory. Details of this development will be presented when data are available on operating tubes. Quantitative results and a simple formula, placing limitation on the design of such tubes with multianode structures, are given in the Appendix.

Appendix

The theory and experimental results given in this paper can be used as a basis for design in devices using the magnetron-type space charge to furnish electronic control of frequency. Frequency shifts of the order of 8 per cent of 500 Mc have been obtained using split-anode magnetrons.[7] The space charge may be used within a multianode structure attached to the resonant circuit of the magnetron. The theory which has been developed can be used as a basis for convenient design criteria by which anode structure and interaction space designs can be determined which obtain maximum benefit of the space charge and do not permit oscillation.

In the first place, if we wish to make use of the properties of a space charge of negative dielectric constant, we have the condition

$$\omega_f < 0.36\omega_c. \tag{32}$$

This is obtained from Fig. 2. If we wish to place the

[7] These results were obtained by P. H. Peters at the General Electric Research Laboratories.

further restriction that magnetron does not oscillate, we have the well-known condition

$$B < B_0. \tag{33}$$

If (32) and (33) are combined so that the structure will not oscillate and the space charge will cause total reflection, we obtain the following:

$$\omega_f < 0.36\omega_c = 0.36\,\frac{Be}{m} < 0.36 \times B_0\frac{e}{m}$$

$$= 0.36 \times \frac{2\omega_f}{n}\,\frac{1}{1-\frac{r_c^2}{r_a^2}}$$

which results in the simple criterion

$$1 - \frac{r_c^2}{r_a^2} < \frac{0.72}{n}$$

or

$$\frac{r_a}{r_c} < \sqrt{\frac{1}{1-0.72/n}}. \tag{34}$$

This last equation gives the following values of r_a/r_c for various values of n:

$n = 1$	$r_a/r_c < 1.88$
2	1.25
3	1.15
4	1.10
5	1.08
6	1.06.

Spacing requirements imposed a limitation on the value of r_a/r_c which can be used and, therefore, on n. For example, if the cathode diameter is of the order of $\frac{1}{2}$ to 1 centimeter, $r_a/r_c < 1.15$ begins to be impractical. Therefore, $N = 2n = 6$ is the largest practical number of anodes. To be on the safe side, $N = 4$ or even $N = 2$ should be used if possible.

If it is desired to make use of the space charge with a positive dielectric constant less than unity the following criterion may be used:

$$\omega_f \gtrsim 1.36\omega_c. \tag{35}$$

ω should not be too much in excess of ω_c; otherwise ϵ_r differs so little from unity that the change in susceptance due to the space charge will not be appreciable. At most, the presence of space charge of these characteristics can do no more than cancel the effect of the cathode. The value of ω_f/ω_c might arbitrarily be limited to less than two for this case. If this is done, we have as before

$$1 - \frac{r_c^2}{r_a^2} < \frac{4}{n}$$

or

$$\frac{r_a}{r_c} < \sqrt{\frac{1}{1-4/n}}. \tag{36}$$

This imposes no serious restriction on r_a/r_c and is actually satisfied in most conventional continuous-wave magnetrons operating at wavelengths greater than 6 centimeters.

The relative merits of these two types of behavior under conditions of high radio-frequency voltage are not yet experimentally determined. On paper the use of space charge of negative dielectric constant can produce an infinite change in λ_0, whereas the space charge of positive dielectric constant can only cancel the effect of the cathode. This latter, of course, can be two to five per cent. The linearity of frequency change and losses under the influence of high radio-frequency voltage might give preference to the latter method. This remains to be seen. The following illustrative cases give quantitative comparison of experimentally observed results with the theory.

The total capacitance in the resonant circuit of any magnetron must include the capacitance between anode and cathode. The latter is the portion which is varied by the presence of the space charge. Let

C_a = total anode-to-anode capacitance including effect of cathode
C_c = total anode-to-cathode capacitance
ΔC_c = change in anode-to-cathode capacitance caused by presence of space-charge swarm.

For a given ΔC_c it can be shown that the resonant wavelength shift is given approximately by

$$\frac{\Delta\lambda_0}{\lambda_0} = \alpha\,\frac{C_c}{C_a}\,\frac{\Delta C_c}{C_c}. \tag{37}$$

Here α is a proportionality factor which is equal to $\frac{1}{2}$ in a lumped-constant circuit since, in this case, wavelength is proportional to the square root of the capacitance. In distributed-constant circuits, as is usually the case in a magnetron, α is less than $\frac{1}{2}$ and must be calculated for the particular case.

C_c/C_a is ordinarily four or five per cent. By particular design it can be made 20 per cent or more.

The method of calculation of $\Delta C_c/C_c$ varies with the geometry and the effective dielectric constant of the space charge. The following two examples are typical.

If $0 < \epsilon_r < 1$ and the space between anode and cathode is just filled by the space-charge swarm (thus having maximum effect),

$$\frac{\Delta C_c}{C_c} = \epsilon_r - 1 \tag{38}$$

where, since ϵ_r is less than unity, the wavelength shift is always negative and the maximum value of shift corresponds to $\Delta C_c/C_c = -1$. In this case the effect of

the cathode is cancelled. Table I gives two sample calculations for this case. ϵ_r is calculated from (23).

In the case of negative ϵ_r, total reflection should occur from the space charge. The cathode diameter is therefore effectively increased by the presence of the space charge. The capacitance between anode and cathode will be a function of the following form:

$$C_c = \frac{K}{\ln r_a/r_c} \tag{39}$$

where K is a function of r_a/r_c because of fringing effects around the anodes. The percentage change in effective capacitance to the cathode is therefore the following, if we consider r_H (radius of the space-charge cloud) as a reflecting surface:

$$\frac{\Delta C_c}{C_c} = \frac{\dfrac{K_H}{\ln r_a/r_H} - \dfrac{K_c}{\ln r_a/r_c}}{\dfrac{K_c}{\ln r_a/r_c}}$$

$$\frac{\Delta C_c}{C_c} = \frac{K_H \log r_a/r_c}{K_c \log r_a/r_H} - 1. \tag{40}$$

Using this result in (37), the following result were obtained in two different tubes constructed in the University of Michigan laboratory. In the second case, a negative dielectric constant is actually not predicted by the theory, but the direction of wavelength shift indicates that the space charge is reflecting. This sort of discrepancy may be due to errors in determination of magnetic field or to the oversimplified nature of the theory.

In the optimum design of a modulator tube, α should be made as large as possible. The second case of Table II illustrates this point. Although a capacitance change of 123 per cent is obtained, due to the small value of α, the wavelength shift is less than one per cent.

Acknowledgments

The author is indebted to all of his co-workers in the University of Michigan Electron Tube Laboratory, particularly to W. G. Dow, who suggested the technique of hot impedance testing, and to J. R. Black, G. R. Brewer, and Miss Rita Callahan, who offered many helpful suggestions and assisted in gathering of experimental information.

TABLE I

Comparison of Theory and Results for $0<\epsilon_r<1$ in the Space-Charge Swarm

E_a volts	B gauss	λ cm	r_a/r_c	r_H/r_c	ω_f/ω_c	C_c/C_a	α	ϵ_r-1 $(\Delta C_c/C_c)$	$\frac{\Delta\lambda_0}{\lambda_0}$ Calculated	$\frac{\Delta\lambda_0}{\lambda_0}$ Observed
190	210	16.85	1.66	1.66	3	0.045	0.5	−0.07	−0.16 per cent	−0.18 per cent
450	450	17.6	1.66	1.66	1.35	0.045	0.5	−1	−2.25 per cent*	−1 per cent

* Note from the solid curve in Fig. 2(a) that ϵ_r is a very critical function of magnetic field in this region so that a 1-per cent error in determined field could produce almost a 100-per cent error in the calculated wavelength shift.

TABLE II

Comparison of Theory and Results for $\epsilon_r<0$ in the Space-Charge Swarm

E_a volts	B gauss	λ cm	r_a/r_c	r_H/r_c	ω_f/ω_c	C_c/C_a	α	$\Delta C_c/C_c$	$\frac{\Delta\lambda_0}{\lambda_0}$ Calculated	$\frac{\Delta\lambda_0}{\lambda_0}$ Observed
1,400	1,700	16.9	1.66	1.11	0.35	0.045	0.5	+0.25	+0.55 per cent	+0.65 per cent
1,400	1,400	13.2	1.33	1.17	0.58	0.05	0.125*	+1.23	+0.77 per cent	+0.76 per cent

* These data were taken on a double-anode modulator tube with a distributed constant circuit—hence the low value of ω. All other data were taken on an interdigital magnetron in which the capacitance was essentially concentrated in the anodes.

Comparison of Tropospheric Reception at 44.1 Mc with 92.1 Mc Over the 167-Mile Path of Alpine, New Jersey, to Needham, Massachusetts*

GREENLEAF W. PICKARD†, FELLOW, IRE, AND HARLAN T. STETSON†, ASSOCIATE, IRE

IN A PREVIOUS paper,[1] the authors rendered an account of field intensity measurements of W2XMN at 42.8 Mc made at the Cosmic Terrestrial Research Laboratory at Needham, Mass., during 1945 and a part of 1946, and exhibited certain relations found with meteorological conditions. On January 24, 1947, the frequency of W2XMN was changed from 42.8 Mc to 44.1 Mc, and in the summer of that year a higher frequency was transmitted from the same tower at Alpine as station W2XEA at a frequency of 92.1 Mc, with substantially equal power on both frequencies. This gave an opportunity for making comparative measurements on both the higher and lower frequencies over the same path of Alpine, N. J., to Needham, Mass., 167 miles in length, or 270 kilometers.

Records of W2XEA began on August 15, 1947 on the same schedule as W2XMN 1600–2300 Eastern Daylight Standard Time in summer and Eastern Standard Time in winter. The general picture of Alpine reception from these two stations as received at Needham is that the fields vary widely from second to second, and even from minute to minute. However, when reduced to microvolts/meter, the two fields received at Needham show similar variations with respect to daily and monthly values. The average field of the higher frequency (92.1 Mc) exhibits somewhat higher values than the fields of the lower frequency station.

The authors find variations in both of these fields closely correlatable with atmospheric refraction throughout the interval as determined from calculation of surface refraction utilizing meteorological data obtained at Boston. Meteorological data at New York or Hartford proved less satisfactory for correlation purposes. The inference is that variation in reception appears to be more influenced by surface conditions at the receiving end than at the other points examined along the path.

The data for W2XMN 44.1 Mc comprise a total of 2,112 hours and W2XEA 2,154 hours. Because of the importance of over-the-horizon transmission, a percentage distribution with respect to time and decibels has been determined. The authors believe the close comparison of both lower and higher frequencies with atmospheric refraction suggest a common mode of propagation and that refractive bending in the lower atmosphere is a major factor for both frequencies.

Considering other modes of propagation, it would appear that duct transmission should be relatively infrequent for the longer waves of the lower frequency, but if significant on the higher frequency paths, a greater difference would be apparent in the field intensity data gathered. Since both frequencies, however, respond similarly to meteorological changes, there seems to be little evidence from these observations that duct transmission is a dominant factor in tropospheric reception at the frequencies observed unless the assumption of a value of 7 kilometers for a critical duct width at 7 meters is to be questioned.

In the interest of space, plotted values of relative fields in log microvolts/meter are exhibited in weekly means on the accompanying diagram for both W2XMN and W2XEA together with the calculated surface refraction over the interval from August, 1947, to December, 1948.

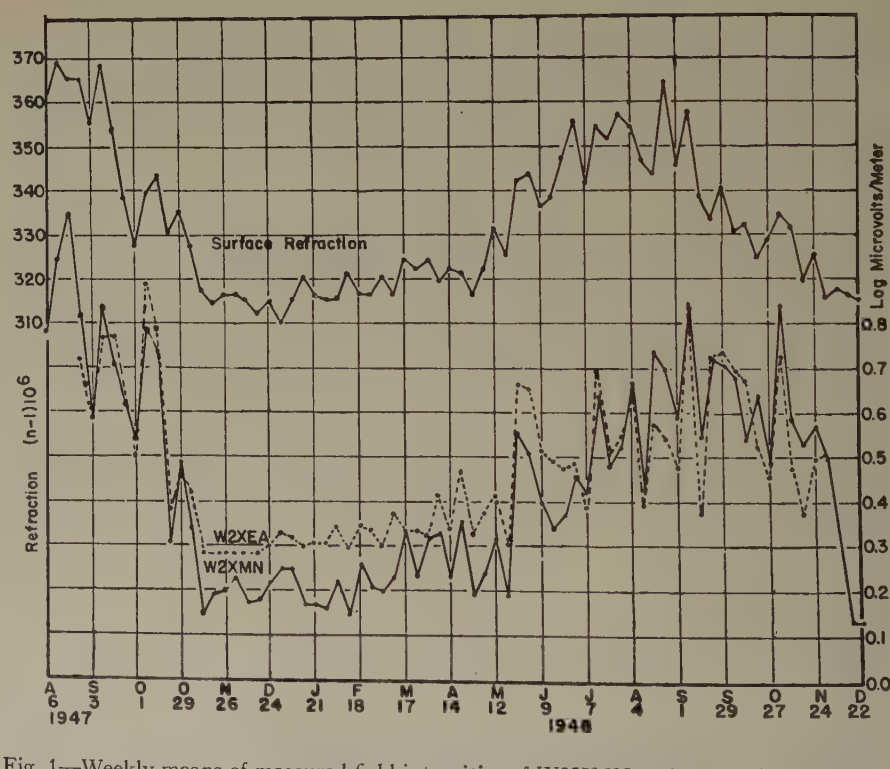


Fig. 1—Weekly means of measured field intensities of W2XMN and W2XEA at Needham, Mass., compared with corresponding atmospheric surface refraction at Boston, Mass.

* Decimal classification: R112.2. Original manuscript received by the Institute, June 7, 1949; abstract received, August 8, 1950.

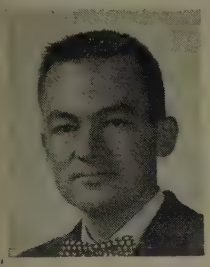
Abstract based on an extension of a paper originally presented at the International Council of Scientific Unions, Oslo, Norway, August 16–18, 1948.

† Cosmic Terrestrial Research Laboratory, Needham, Mass.

[1] G. W. Pickard and H. T. Stetson, "A study of tropospheric reception at 42.8 Mc. and meteorological conditions," PROC. I.R.E., vol. 35, pp. 1445–1451; December, 1947.

Contributors to the Proceedings of the I.R.E.

Russell C. Coile was born in Washington, D. C., on March 11, 1917. He attended the Massachusetts Institute of Technology where he received the S.B. and S.M. degrees in electrical engineering in 1938 and 1939, respectively, as well as the E.E. degree in 1950. While still an undergraduate he served as student engineer with the General Electric Company, was later an engineer's assistant at the Western Electric Company in Kearney, N. J., and, in 1938–1939, was research assistant at the MIT Electrical Engineering Research Laboratories.



RUSSELL C. COILE

From 1939 to 1942 Mr. Coile held the post of magnetician in the Department of Terrestrial Magnetism at the Carnegie Institution, Washington, D. C. As a reserve officer in the Army Signal Corps, he was called to active duty in World War II, emerging with the rank of major in the Officers Reserve Corps of the Army Air Corps in 1945.

That same year Mr. Coile joined the firm of Colton & Foss, Inc., Washington, D. C., as an electronic engineer. He is now a staff member of the Operations Evaluation Group, Division of Industrial Cooperation, at MIT, a position he has held since 1947.

He is a member of Sigma Xi and Eta Kappa Nu fraternities.

❖

W. Hackett was born in Smethwick, Staffordshire, England. She obtained her technical education at the University of Birmingham, receiving the B.Sc. degree in electrical engineering in 1929 and the Ph.D. degree in 1931.

W. HACKETT

As a technical assistant with the British Electrical and Allied Industries Research Association, London, from 1933 to 1944, she was concerned with the development of research and commercial methods of test for dielectric materials and components, and is the author or co-author of a number of papers on the subject. From 1944 to 1946 she was in the employ of A. H. Hunt Ltd., Capacitor Manufacturers, London, engaged on theoretical work and in charge of the test section of the laboratory. Since January, 1947, she has been engaged mainly on circuit analysis with British Telecommunications Research Ltd., Taplow, Bucks., England.

She has been an associate member of the Institution of Electrical Engineers, London, since 1940.

L. P. Hunter was born in Wooster, Ohio, on February 11, 1916. He received the B.S. degree in physics from the Massachusetts Institute of Technology, the B.A. degree from the College of Wooster, and the M.S. and D.Sc. degrees from Carnegie Institute of Technology.

L. P. HUNTER

In 1940 Dr. Hunter joined the Westinghouse Electric Corporation, engaging in work on the physics of solids. His first investigation involved the behavior of the elastic constants during phase changes in solids. During the war he was engaged in microwave magnetron development, and later spent a year at the University of California working on the calutron project. Since the war Dr. Hunter has spent some time in X-ray research. In the summer of 1948 he was a member of the Lexington Evaluation Project of the A.E.C. He has just returned to Westinghouse from a two-year leave at the Oak Ridge National Laboratory, where he was engaged in a study of radiation effects in solids, and is now manager of a section working on solid-state electronics.

Dr. Hunter is a member of the American Physical Society and its division of solid-state physics.

❖

Joseph Manuele was born in Fredonia, N. Y., on November 23, 1897. He was graduated from the Massachusetts Institute of Technology in 1925 with the B.S. degree in electrical engineering, after which he joined the Westinghouse Electric Corporation. Beginning as an inspector of railway equipment, he gained further experience inspecting radio apparatus, power induction regulators, network protectors, and switchboard. In 1930 he was assigned to the headquarters inspection office, and was appointed director of quality control in 1940, his present position.

JOSEPH MANUELE

Previous to his entrance to MIT, Mr. Manuele worked for the United States Radiator Corporation, and the Atlas Crucible Steel Company, where he sampled, stored, and issued various ferro alloys, and eventually became first melter on a six-ton electric furnace. He gave up this position to obtain a high school diploma from Valparaiso University by special examination, after which his credits were accepted by MIT.

Joe Cyril May (S'44–A'46–M'48) was born in McCurtain, Okla. on May 5, 1923. He received the B.S. degree in electrical engineering from Oklahoma Agricultural and Mechanical College in 1944, and the M.E. degree in electrical engineering from Yale University in 1947. He became an instructor in electrical engineering in 1944 and was appointed to the rank of assistant professor in 1949. He has been associated with research on split-anode magnetrons and radar signal-to-noise investigations.

J. C. MAY

Mr. May is at present Membership Chairman of the Connecticut Valley Section of The Institute of Radio Engineers. He is also a member of the American Institute of Electrical Engineers, Sigma Tau, and Eta Kappa Nu.

❖

Herbert J. Reich (A'26–M'41–SM'43–F'49) was born on Staten Island, N. Y., on October 25, 1900. He received the M.E. degree from Cornell University in 1924, and the Ph.D. degree in physics in 1928. In 1929 he joined the department of electrical engineering at the University of Illinois, where he became assistant professor, associate professor, and professor, successively, of electrical engineering. In January, 1944, he was granted leave of absence to join the staff of the Radio Research Laboratory at Harvard University. In January, 1946, Professor Reich was appointed professor of electrical engineering at Yale University, where he is at present.

HERBERT J. REICH

Dr. Reich has specialized in the field of electron tubes and electron-tube circuits, having published numerous papers on these and related subjects in various technical journals. He is the author of "Theory and Applications of Electron Tubes," and "Principles of Electron Tubes," as well as co-author of "Ultra-High-Frequency Techniques."

Dr. Reich is a Director of the IRE, and has served on numerous IRE committees. At present, he is a member of the Board of Editors, the Electron Tube Committee, and the Education Committee of which he is Chairman. He is a member of the American Institute of Electrical Engineers, the American Association for the Advancement of Science, the American Society for Engineering Education, and is a Fellow of the American Physical Society.

Henry E. Singleton (A'47–SM'50) was born on November 27, 1916, at Haslet, Texas. He received the S.M. and S.B. degrees in electrical engineering from the Massachusetts Institute of Technology in 1940. From 1941 to 1946 he worked for the Navy, first with the Naval Ordnance Laboratory and later as a member of the Operations Research Group of the Office of Scientific Research and Development, attached to *Cominch*, U. S. Fleet. After the war he spent two years with the International Telephone and Telegraph Corporation, in New York, N. Y. In 1948 he returned to MIT, where he has been engaged in research on digital computers and nonlinear networks. He is now an instructor in electrical engineering at MIT.

H. E. Singleton

Mr. Singleton received the William Lowell Putnam prize in mathematics in 1939. He is a member of Eta Kappa Nu, and is serving on the Annual Review Committee and the Technical Committee on Modulation Systems of the IRE.

❖

J. G. Skalnik (S'46–A'48) was born in Medford, Okla., on May 30, 1923. He received the B.S. degree in electrical engineering from Oklahoma Agricultural and Mechanical College in 1943, and the M.E. degree in electrical engineering from Yale University in 1947. He became an instructor in electrical engineering at Yale University in 1944, and in 1949 was appointed assistant professor. He has been associated with research on split-anode magnetrons, radar signal-to-noise investigations, and transistors.

J. G. Skalnik

Mr. Skalnik is a member of the American Institute of Electrical Engineers.

❖

Norman H. Taylor (SM'50) was born in Manchester, England, on November 15, 1916. He received the B.S. degree from Bates College in 1937 and the S.B. degree in electrical engineering from Massachusetts Institute of Technology in 1939. He received his early training and spent the war years at the Western Electric Company in the Test Equipment Development Engineering Group. Since 1947 he has been at the Servomechanisms Laboratory, MIT, doing research and development on electronic computers. He is at present systems engineer on the Whirlwind digital computer.

N. H. Taylor

Mr. Taylor is a member of Eta Kappa Nu and Sigma Xi. He is now serving as a member of the Measurements and Instrumentation Committee of the IRE.

❖

Robert L. Ungvary (S'43–A'45–M'50) was born in Stamford, Conn., on April 17, 1921. He received the B.E. degree in electrical engineering in December, 1942, from Yale University. Following a period of war service as a radar officer in the Pacific area, Mr. Ungvary returned to graduate study at Yale, receiving the M.E. degree in June, 1947. He remained at Yale as a research assistant, engaged in classified project work for the Office of Naval Research, until June, 1949. In July, 1949, he joined the engineering staff of the Raytheon Manufacturing Company and is currently engaged in development of airborne radar equipment.

R. L. Ungvary

Mr. Ungvary is an associate of the American Institute of Electrical Engineers and a member of Sigma Xi.

❖

H. William Welch, Jr., (A'47) was born in Beardstown, Ill., on October 21, 1920. He received the B.A. degree in physics and was elected to Phi Beta Kappa at De Pauw University in 1942. After a summer with the Eastman Kodak Company test laboratories, he spent a year at the University of Wisconsin in graduate study, research, and teaching. In 1943 he went to the Harvard University Radio Research Laboratory as a research associate, where he became involved in magnetron research and development. After spending the first six months of 1946 as a part-time instructor of physics at Purdue University he went to the University of Michigan Engineering Research Institute as a research physicist. He is presently concerned with problems of microwave-tube electronics in the Department of Electrical Engineering Electron Tube Laboratory.

H. W. Welch, Jr.

Mr. Welch received the M.S. degree in physics at the University of Michigan in 1948. He is a member of Sigma Xi and the American Physical Society.

Wilfrid B. Whalley (A'37) was born in Liverpool, England, in 1908. He moved to Canada in 1919. He received the B.A.Sc. degree from the University of Toronto in 1932, following which he was on the staff of the department of electrical engineering for four years and, in 1935, he received the M.A.Sc. degree.

W. B. Whalley

In 1936 Mr. Whalley was a development engineer at the Radio Valve Company in Toronto. From 1937 to 1940 he was with the RCA Manufacturing Company in Harrison, N. J., following which he transferred to war work on radar systems and cathode-ray tubes in Canada. In 1943, Mr. Whalley returned to RCA to engage in research on radar and television transmitting tubes and circuits. He was appointed assistant professor of engineering physics at Cornell University in 1947. At present, he is concerned with television research and development at the physics laboratories of Sylvania Electric Products Inc.

Mr. Whalley is a member of Sigma Xi, American Association of University Professors, and the American Physical Society.

❖

Harold A. Wheeler (A'27–M'28–F'35) was born in St. Paul, Minn., on May 10, 1903. He received the B.S. degree in physics from George Washington University in 1925. From 1925 to 1928 he pursued postgraduate studies in the physics department of The Johns Hopkins University, and lectured there during 1926 and 1927. He was employed as a laboratory assistant in the radio section of the National Bureau of Standards in 1921, leaving in 1923 to assist Professor Hazeltine and later to join the Hazeltine Corporation in 1924. He was in charge of their Bayside laboratory from 1930 to 1937, and advanced to the position of vice-president and chief consulting engineer of Hazeltine Electronics Corporation.

H. A. Wheeler

In 1946 Mr. Wheeler opened his own consulting office in Great Neck, L. I., N. Y. He is now also president of Wheeler Laboratories, Inc., an engineering organization engaged in consultation and the construction of special equipment. Mr. Wheeler is a Fellow of the American Institute of Electrical Engineers and a member of Sigma Xi. He received the Morris Liebmann Memorial Prize in 1940, and was a member of the Board of Directors of the IRE in 1934, and from 1940 to 1945.

Correspondence

Reflected Ray Suppression*

In line-of-sight microwave communications, destructive interference between the direct and the ground-reflected rays may interrupt the service. Although the receiver is sited originally to be in an interference maximum, subsequent atmospheric changes may shift the spatial interference pattern of the source and its image, putting the receiver in a minimum. Diversity reception can be used to alleviate this difficulty. The present note proposes as an alternative remedy that a small screen be set on the ground at the "reflection point" in the path in such a way that the reflected ray at the receiver will disappear almost entirely in theory, and in practice to an extent which depends mostly on the smoothness of the ground plane. The direct wave itself will be only slightly modified. The screen blocks a small part of the reradiation from the ground to the receiver, the design being such that the remainder of the reflected radiation cancels itself to zero at the receiver. Model experiments over an 800-foot transmission path have shown that the scheme is successful.

The foundation for this scheme rests on the fact that the wave field from a point source to a point receiver under free-space conditions becomes zero if part of a Fresnel zone is blocked off in such a way that the remaining diffracted contribution of the zone is unchanged in phase and halved in amplitude. One way to explain the reflection elimination is to use the "method of images." This makes the reflection problem into a free-space transmission problem. The ground plane is removed, there is the source and its image and the screen and its image,[1] and one receiver. To eliminate the image source an opaque quarter-circle whose radius equals the radius of the first Fresnel zone may be erected on the ground. One of the straight edges is on the ground and the other is vertical and exactly centered in the path. The plane of the screen is perpendicular to the path. It is put at the place where the central ray to the image would intersect the ground plane. It may be said that one half of the first Fresnel zone to the image source is blocked by a half-circle; the remaining contribution from this zone is unchanged in phase, and thus the image source is eliminated at the focal point (the receiver). There is a large area around this point where the image is nearly eliminated. It may be noted that a sector of a circle is only one of a large variety of screens which can eliminate a source, or an image source.

In the experiments, a 4,500-Mc transmitter was placed 800 feet from the receiver and 14.3 feet above the ground; the antennas at each end were 4- by 6-inch horns. The receiver could be elevated up and down a 50-foot tower. Numerous tests were made using various shapes and placements of screens. Fig. 1 shows an example of the results obtained. Two triangular screens whose edges were 7.3, 6.6, and 5.4 feet were used for this trial. The figure shows an original recorder tape; time progresses upward on the tape. First, with the path unobstructed, the receiver makes a descent from 4 meters to zero meters (see the height markers on the extreme right). The interference of the reflected ray creates a well-defined pattern. Then the receiver makes an ascent with the two triangular screens eliminating the reflected ray. The correct position for the screens moves along the path as the receiver elevates, therefore the ascent was stopped every half-meter in order to reset the screens. The influence of the reflected wave is mostly eliminated at the receiver and the remaining direct wave has the correct strength, 6 decibels weaker than in the former interference maxima.

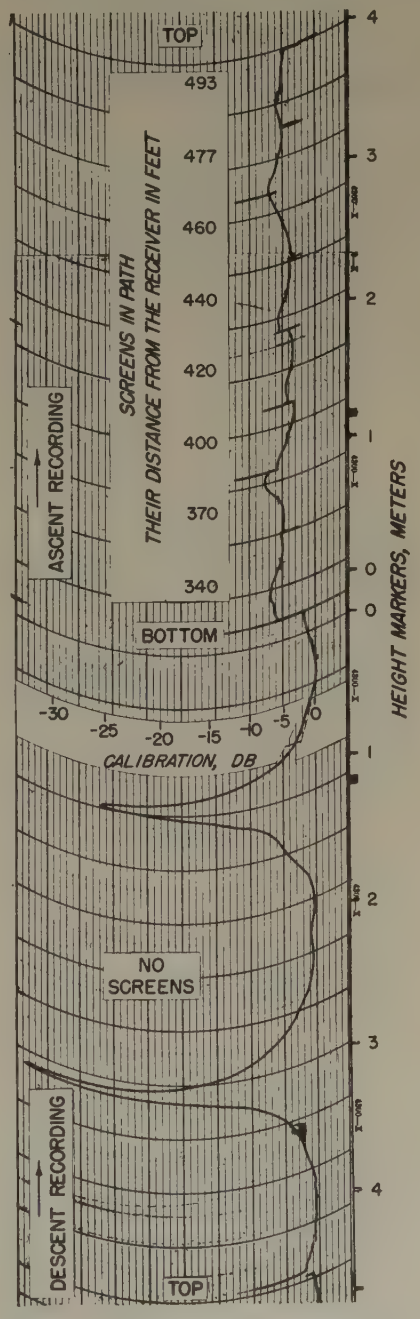


Fig. 1—Signal-strength-versus-height record showing reflected wave suppression. Height markers on right; zero mark is about 7 feet above the ground. (The break in the record marks an equipment difficulty.)

The experiments confirm the theory and indicate that trouble with a strong reflected wave can be eliminated by erecting small screens in the path, or when possible by taking advantage of an obstacle already present. In many cases it may be sufficient to reduce the apparent reflection coefficient to the order of six or seven tenths in order to render the reflected wave rather harmless; and to accomplish this much reduction only a very small screen is needed.

HOWARD E. BUSSEY
Tropospheric Propagation Research Section
Central Radio Propagation Laboratory
Washington 25, D. C.

A Note on the Synthesis of Resistor-Capacitor Networks*

In their paper on the synthesis of *R-C* lattice networks,[1] Professors Bower and Ordung present a method for realizing maximum gain in a prescribed voltage transfer ratio. The method, in the case when the load is negligible, consists of placing one of the roots of an arbitrary polynomial $F_1(p)$ so that one of the equality signs in

$$-1 \leqq \frac{hk_y^{(n)}}{k_y^{(d)}} \leqq 1 \qquad (10)$$

holds at the largest minimum of the prescribed transfer ratio $|A(p)|$ plotted for negative real p.[2] The remainder of the roots of $F_1(p)$ are then placed arbitrarily within prescribed intervals.

By careful placement of the remainder of the roots of $F_1(p)$, it is possible to achieve a design having a maximum gain factor *with a minimum number of elements*. Such a design is obtained by making one or the other of the equality signs in (10) hold at *each* of the roots of $F_1(p)$. This can always be done, once h has been chosen for maximum gain or less. The result is that Z_a and Z_b (see (7) and (9)) each have different poles, the total number n being equal to the degree of $F_1(p)$. Thus the degenerate lattice designed on this basis will contain n capacitors, rather than the $2n-1$ which result when the remainder of the roots is placed arbitrarily. Since h is generally chosen on the basis of the maximum gain requirement alone, and since

* Received by the Institute, March 30, 1950.
[1] The use of an image screen in this explanation was suggested by my colleague, J. H. Chisholm.

* Received by the Institute, May 1, 1950.
[1] J. L. Bower and P. F. Ordung, "The synthesis of resistor-capacitor networks," PROC. I.R.E., vol. 38, p. 263; March, 1950.
[2] All equation numbers refer to the aforementioned paper.

$$\frac{hk_p^{(n)}}{k_p^{(d)}} = hA\Big|_{p=\gamma_p},$$

it is evident that all of the roots of $F_1(p)$ should be placed at points in their prescribed intervals where $|A| = 1/h$. In some intervals, there is an optional choice between two such values of p.

As an example of the method, consider the transfer ratio

$$A = \frac{p^2 + 42p + 3600}{(p+5)(p+300)}.$$

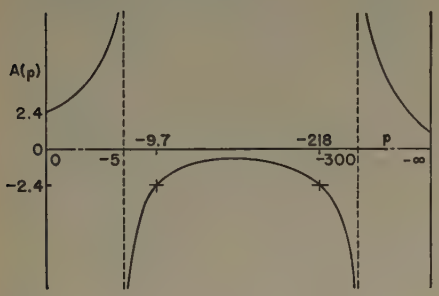


Fig. 1—$A(p)$ for example of unloaded lattice.

A plot of $A(p)$ is shown in Fig. 1. It is evident that for maximum gain, $h = 1/2.4$ and the critical root of $F_1(p)$ is at $p = 0$. The other root of $F_1(p)$ can be placed at $p = -9.7$ or $p = -218$ where $|A| = 2.4 = 1/h$. Both values should be tried in order to achieve the most reasonable spread of element values. For the larger value

$$F_1(p) = p(p + 218).$$

One then obtains

$$Z_a - Z_b = \frac{1}{2.4} \cdot \frac{p^2 + 42p + 3600}{p(p+218)}$$

$$= \frac{1}{2.4}\left[1 + \frac{16.5}{p} - \frac{192}{p+218}\right]$$

$$Z_a + Z_b = \frac{(p+5)(p+300)}{p(p+218)}$$

$$= 1 + \frac{6.87}{p} + \frac{80.2}{p+218},$$

from which

$$Z_a = 0.708 + \frac{6.87}{p}$$

$$Z_b = 0.292 + \frac{80.2}{p+218}.$$

The resulting lattice is shown in Fig. 2.

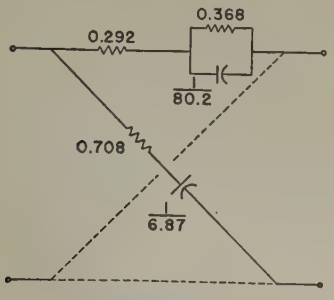


Fig. 2—Lattice network, $F_1(p) = p(p+218)$.

This lattice is easily reduced to three-terminal form, and the final network (Fig. 3) contains only two capacitors.

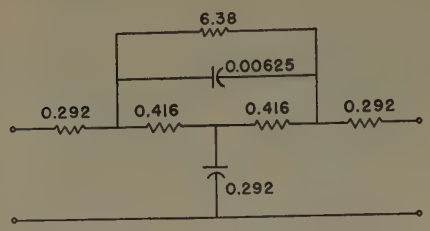


Fig. 3—Reduced network, $F_1(p) = p(p+218)$.

For $F_1(p) = p(p+9.7)$ one obtains

$$Z_a = 0.708 + \frac{155}{p}$$

$$Z_b = 0.292 + \frac{141}{p+9.7}.$$

The final reduced network is shown in Fig. 4.

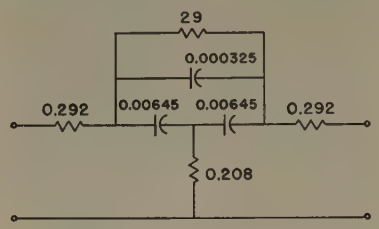


Fig. 4—Reduced network, $F_1(p) = p(p+9.7)$.

CHARLES BELOVE
Yale University
New Haven, Conn.

Relation of Nyquist Diagram to Pole-Zero Plots in the Complex Frequency Plane*

Although the relation of the familiar Nyquist diagram to pole-zero plots is undoubtedly well known to those whose daily work takes them on frequent excursions into the complex frequency plane, it is neither immediately obvious nor commonly mentioned.

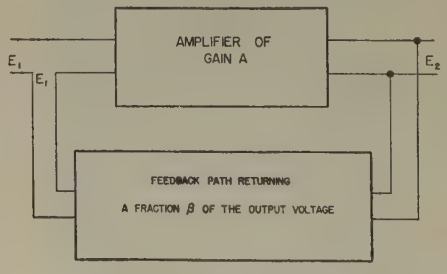


Fig. 1—Closed-loop system.

The closed-loop system of Fig. 1 has a gain, with feedback, of $A/1-A\beta$. The Nyquist criterion for stability states that the system is stable if a polar plot of $A\beta$ does not enclose the point (1, 0). On the other hand, the system is known to be stable if the complex gain E_2/E_1 does not have a pole in the right half of the complex frequency plane $p = \sigma + j\omega$. In other words, stability is insured if the amplifier with feedback does not give infinite gain to signals of the form $Ee^{\sigma t}e^{j\omega t}$ for any positive value of σ. The equivalence of these two statements is easily shown by an example.

* Received by the Institute, June 12, 1950.

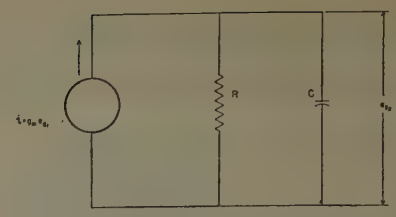


Fig. 2—High-frequency equivalent circuit of resistance-coupled amplifier stage.

Consider an amplifier made up of four identical resistance-coupled stages each having the equivalent circuit of Fig. 2. Let the feedback network be a simple resistance voltage divider so that β is a (negative) constant fraction. The gain of the amplifier, and also the gain around the closed loop

$$A\beta = \beta \frac{A \text{ midband}}{(1 + pRC)^4}$$

have fourth order poles at $p = -(1/RC)$ (Fig. 3). Contours of constant magnitude of

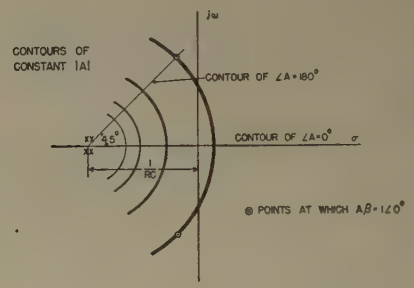


Fig. 3—Pole-zero plot of loop gain $A\beta$.

$A\beta$ are concentric circles about the point $p = -(1/RC)$; contours of constant phase shift around the closed loop are radial lines. At the two points indicated in Fig. 3 the magnitude of $A\beta$ is assumed to be unity and the phase shift of A is 45° per stage or a total phase shift in the amplifier of 180°.

Consider now the overall gain with feedback, $A/1-A\beta$. It will have poles for the values of p for which $A\beta = 1$. The system is stable if these poles all fall in the left half of the complex frequency plane; unstable if any fall in the right half plane. (Fig. 4.)

Fig. 4.—Poles of over-all gain (with feedback) $A/1-A\beta$ corresponding to points $A\beta = 1$ in Fig. 3.

It remains to relate these plots to the Nyquist plot of loop gain $A\beta$ of Fig. 5. This is a simple matter—the gain is a rational function of the complex frequency p and the Nyquist plot of Fig. 5 is a conformal mapping of the positive $(j\omega)$ axis of Fig. 4. The first quadrant of the complex frequency plane maps into the shaded area of Fig. 5. Thus the

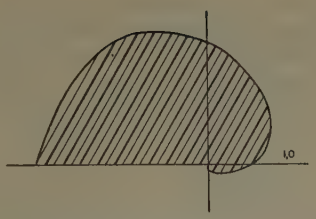


Fig. 5—Nyquist polar plot of $A\beta$.

statements for a stable system that the point (1, 0) must lie outside the Nyquist plot, and that the over-all gain must have no poles in the right half of the complex frequency plane are completely equivalent.

W. W. Harman
University of Florida
Gainesville, Fla.

Elliptically Polarized Waves*

In the paper "Antennas for Circular Polarization," by Sichak and Milazzo,[1] an expression is derived for the voltage induced in an arbitrarily elliptically polarized receiving antenna by an elliptically polarized wave. The derivation is based on the fact that the elliptically polarized waves may be assumed to be made up of two linearly polarized components. This expression is equation (2) of the above paper.

$$V = K\left[1 \mp \frac{2r_2r_1}{(r_2^2+1)(r_1^2+1)} + \frac{(r_2^2-1)(r_1^2-1)}{(r_2^2+1)(r_1^2+1)}\cos 2\alpha\right]^{1/2}, \quad (1)$$

where K is a constant, r_1 is the axial ratio of the receiving antenna, r_2 is the axial ratio of the transmitting antenna, and α is the angle between the major axes of the two ellipses of polarization. The $(-)$ sign is used if the senses of rotation of the two antennas are opposite and the $(+)$ sign is used if the senses are the same.

An alternate method of approach, and one which is perhaps simpler and more physically apparent, is to assume that an elliptically polarized wave is made up of two circularly polarized components of opposite sense of rotation, and of the proper relative phase and magnitude. The sense of rotation of the resultant wave is the same as the sense of the larger component. Then

$$r_1 = \left|\frac{R_1+L_1}{R_1-L_1}\right|, \qquad r_2 = \left|\frac{R_2+L_2}{R_2-L_2}\right|, \quad (2)$$

where R_1, L_1, R_2, L_2, are the right- and left-handed amplitude components of the receiving and transmitting antennas, respectively. Also

$$\frac{R_1}{L_1} = \frac{r_1+1}{r_1-1} \text{ for right-handed waves,}$$

$$= \frac{r_1-1}{r_1+1} \text{ for left-handed waves, and}$$

$$\frac{R_2}{L_2} = \frac{r_2+1}{r_2-1} \text{ for right-handed waves,}$$

$$= \frac{r_2-1}{r_2+1} \text{ for left-handed waves.} \quad (3)$$

If the major axes of the ellipses of polarization of the transmitting and receiving antennas are at angles γ and β, respectively, then the resultant fields may be represented as

$$E_2 = R_2e^{j(2\pi-2\gamma)} + L_2$$
$$E_1 = R_1 + L_1e^{j(2\pi-2\beta)}. \quad (4)$$

The voltage induced at the receiver terminals of an antenna, compared to that which would be induced if both antennas were correctly linearly or circularly polarized, is

$$\frac{V_R}{V_0} = \left| R_2R_1e^{j(2\pi-2\gamma)} + L_2L_1e^{j(2\pi-2\beta)}\right|$$
$$= \left| R_2R_1e^{j2\alpha} + L_2L_1\right| \quad (5)$$

Where $\alpha=\beta-\gamma$. Expanding,

$$\frac{V_R}{V_0} = [R_1^2R_2^2+L_1^2L_2^2+2R_1R_2L_1L_2\cos 2\alpha]^{1/2} \quad (6)$$

Usually it is more convenient to express (6) in terms of the axial ratios. Using the relations (3) and realizing that $R^2+L^2=1$, (normalizing the power in the wave), we may substitute in (6) and get for the power received relative to the maximum power

$$\frac{P_R}{P_0} = \left(\frac{V_R}{V_0}\right)^2$$
$$= \frac{(1+r_2)^2(1\pm r_1)^2+(1-r_2)^2(1\mp r_1)^2}{4(1+r_2^2)(1+r_1^2)} + \frac{(1+r_2)(1-r_2)(1+r_1)(1-r_1)}{2(1+r_2^2)(1+r_1^2)}\cos 2\alpha$$
$$= \frac{1}{2} \pm \frac{2r_1r_2}{(1+r_1^2)(1+r_2^2)} + \frac{(1-r_1^2)(1-r_2^2)}{2(1+r_1^2)(1+r_2^2)}\cos 2\alpha. \quad (7)$$

The $(+)$ sign is used when the two antennas have the same sense of rotation and the $(-)$ when the sense of rotation is opposite. This result (7) is the same as Sichak and Milazzo's (1). This is made obvious by squaring both sides of the latter expression, and dividing both sides by $2K^2$, since $P_0=2K^2$.

This derivation has as an interesting and useful by-product, equation (6). This latter form may be conveniently used for many cases, particularly where it is easier to deal with right- and left-handed components, rather than axial ratios. For instance, consider two antennas linearly polarized in the same direction. Here $R_1=R_2=L_1=L_2=0.707$ and $\alpha=0$. Therefore $V_R/V_0=[0.25+0.25+0.50]^{1/2}=1$. If on the other hand the two antennas are orthogonal, $\alpha=90°$, and $V_R/V_0=0$. Similarly if two right-handed circularly polarized antennas are used, $R_1=R_2=1$, $L_1=L_2=0$ and $V_R/V_0=1$, as is also the case for two left-handed antennas. If, however, one left- and one right-handed antenna are used, $R_1=L_2=0$, and $R_2=L_1=1$, or $R_1=L_2=1$ and $R_2=L_1=0$, and $V_R/V_0=0$.

The case for optimum power transfer is readily determined from (6) or (7). The conditions are $\alpha=0$, and either the polarization parameters $R_1=R_2$ and $L_1=L_2$ in (6), or the sense of rotation of the two antennas is the same and $r_1=r_2$ in (7).

Leonard Hatkin
Signal Corps Engineering Laboratories
Fort Monmouth, N. J.

* Received by the Institute, May 21, 1950.
[1] W. Sichak and S. Milazzo, "Antenna for circular polarization," Proc. I.R.E., vol. 36, pp. 997–1002; August, 1948.

An Achromatic Microwave Antenna*

Several years ago the writers were interested in the design of an achromatic microwave antenna for wide angle scanning. The use of constrained transmission through a metal plate lens seemed promising because thereby Abbe's sine condition can be satisfied and the design is simpler than for nonconstrained transmission. It is recognized that Abbe's sine condition is only an approximate requirement and that, therefore, the angle of scan attainable with this lens probably will not approach that recently disclosed in the literature.[1] The achromatic feature should, however, be interesting.

Figs. 1 and 2 show two such antennas

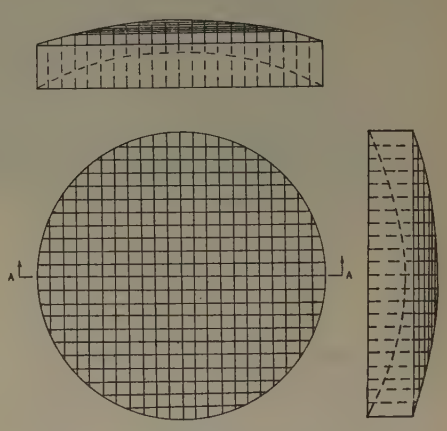


Fig. 1—Lens antenna for pencil-shaped beam.

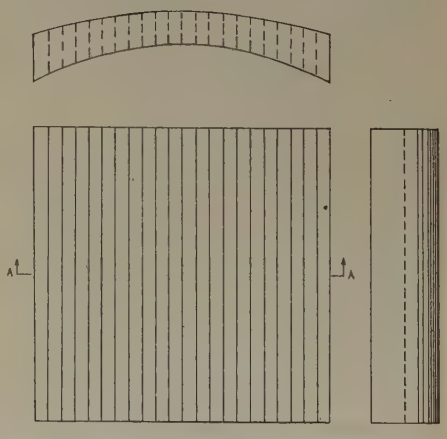


Fig. 2—Lens antenna for fan-shaped beam.

having, respectively, a pencil-shaped and a fan-shaped beam. Note that the first is doubly constrained. Fig. 3 shows a section AA through either antenna perpendicular to the metal plates. The electric field is polarized to be perpendicular to this section. Surface (X_1, Y) is a sphere or cylinder whose center is at F and whose radius is a. In order to satisfy Abbe's sine condition for minimum coma, the antenna feed is located at F (i.e., the focal length is a). A phase shift invariant with frequency, but varying from point to point such that the spherical aberration vanishes, is assumed to exist at surface (X_1, Y). This

* Received by the Institute, May 25, 1950.
[1] J. Ruze, "Wide-angle metal-plate optics," Proc. I.R.E., vol. 38, pp. 53–59; January, 1950.

condition can be approximated by properly modifying this ideal surface to eliminate the spherical aberration, and by utilizing steps to bring the modified surface back to the vicinity of the ideal surface, wherever the deviation becomes excessive. Surface (X, Y) is chosen to minimize the chromatic aberration.

The dotted line represents the path of a ray going from F to (X_1, Y) to (X, Y) to a plane perpendicular to and cutting the axis at the vertex of the surface (X, Y).

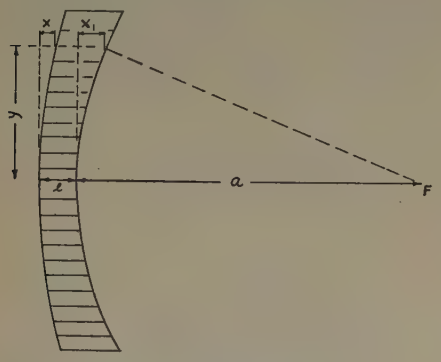


Fig. 3—Cross section (AA) through either antenna.

In order that the lens shall be achromatic, the difference measured in wavelengths, between the dotted and the axial paths, should not change with frequency. While this can not be done exactly, it can be accomplished for two frequencies. If these two frequencies are located near the edges of the frequency band in which the lens is to operate, the lens can be made approximately achromatic over the whole band. That is,

$$\phi(y) + \frac{a+x}{\lambda_1} + \frac{x_1+l-x}{\lambda_{g_1}} - \phi(0) - \frac{a}{\lambda_1} - \frac{l}{\lambda_{g_1}} = \phi(y) + \frac{a+x}{\lambda_2} + \frac{x_1+l-x}{\lambda_{g_2}} - \phi(0) - \frac{a}{\lambda_2} - \frac{l}{\lambda_{g_2}} \quad (1)$$

where

$\phi(y)$ is the surface phase shift at points (X_1, Y) or (X, Y)

$\phi(o)$ is the surface phase shift at point (0, 0)

λ_1 is the free-space wavelength corresponding to one frequency

λ_2 is the free-space wavelength corresponding to the other frequency

λ_{g_1} is the wavelength in the lens at λ_1

λ_{g_2} is the wavelength in the lens at λ_2.

Collecting terms, (1) can be written

$$x = \frac{x_1}{1 - \dfrac{1/\lambda_1 - 1/\lambda_2}{1/\lambda_{g_1} - 1/\lambda_{g_2}}}$$

or

$$x = \frac{x_1}{1 - \dfrac{f_1 - f_2}{n_1 f_1 - n_2 f_2}} \quad (2)$$

where n_1 and n_2, the indices of refraction, correspond to the frequencies f_1 and f_2, which in turn correspond to λ_1 and λ_2 respectively.

This is the equation of the desired curve. It will be noted that when double constraint is employed, the phase or stepping correction can be applied to either surface (X_1, Y) or (X, Y).

N. I. Korman
J. R. Ford
Radio Corporation of America
RCA Victor Division
Camden, N. J.

Stratospheric-Ionospheric Relationships*

An attempt has been made to determine whether any correlation existed between pressures and temperatures, as found at the tropopause or in the lower stratosphere, and electron densities found in the several ionospheric regions. The original impetus for this investigation arose from the various reported correlations between surface meteorological factors and ionospheric parameters. On the whole, previous studies[1–13] had attempted a direct correlation generally between the barometric pressure at the earth's surface and critical frequencies of the ionospheric layers. However, as surface pressure is highly dependent upon the mass of relatively shallow air masses (of depth mainly less than 3–4 km in the case of polar air) which in many instances rarely affect higher level meteorological conditions, a new datum level for the study was adopted.

There does not seem to be a one-to-one correspondence between barometric pressure variations at the ground and, for example, those at the tropopause. In the atmosphere, high-frequency wave components (cyclone waves) are found which generally do not extend to 9–11 km. In other cases, however, it is not known with certainty whether or not the high-frequency components do extend to the tropopause. In any event, it would seem that those atmospheric disturbances which affect the stratosphere may also be present in sufficient strength to affect the ionized regions also. A correlation might then be attempted between meteorological parameters in the stratosphere (where the magnitude of the high-frequency wave components, found at the surface, is reduced) and ionospheric conditions in the various ionized layers.

An investigation of this type was made between ionospheric layer critical frequency and (a) temperature and pressure at the tropopause and (b) temperature and pressure at an altitude of 13 km. In undertaking the study, radiosonde and ionospheric data for Washington, D. C., were examined for the period January 1, 1946, to December 31, 1947. The criterion adopted for the definition of "tropopause" was that advocated by Flohn and Penndorf.[14] Thus a tropopause was considered to be that point above which the lapse rate first falls below 2°K/km providing this or a lesser lapse rate continues through an altitude range of 1.5 km or more. Instances where no well defined tropopause existed were not included in the analysis. Ionospheric data were obtained from the CRPL[15] series. Only the critical frequency of the ordinary ray was considered. As radiosonde data are available only at 0430 Greenwich Mean Time and 1630 GMT, only two sets of data per day could be employed.

The investigations reveal no correlation between either the temperature or pressure at the tropopause and the critical frequency of any of the ionospheric regions. Also, no correlation was evident between temperatures at 13 km and the critical frequency of the ionospheric layers.

Considering the pressure at 13 km and the critical frequency at the E and F_2 regions, some slight correlation was found in several instances. However, no correspondence was found with sporadic E conditions. Results of the examination are given below in Table I.

N. C. Gerson
Air Force Cambridge Research Laboratories
Cambridge 39, Mass.

TABLE I
Correlation Between Pressure at 13 km and Critical Frequency

Ionospheric Region	*Correlation Coefficient*	*Probable Error of Correlation Coefficient*	*Standard Deviation of Critical Frequency (Mc/s)*	*Standard Deviation of Pressure (mb)*
E layer, daylight	0.53	0.05	0.27	6.4
F_2 layer, daylight	−0.37	0.04	2.22	6.1
F_2 layer, darkness	0.45	0.05	1.20	5.9

Appreciation is expressed to Miss A. M. Walter for her careful assistance in performing the computations.

[1] C. G. Abbott, "Correlation of Solar Variation with Washington Weather," *Smithsonian Misc. Collection*, vol. 104, pp. 1–10; 1945.
[2] J. Bannon, A. J. Higgs, D. F. Martyn, and G. H. Munroe, "The association of meteorological changes with variation of ionization in the F_1 region of the ionosphere," *Proc. Roy. Soc.*, vol. A174, pp. 289–309; 1940.
[3] J. Bannon, A. J. Higgs, and G. H. Munroe, "Magnetic disturbances and region F_1 of the ionosphere," *Terr. Mag.*, vol. 46, pp. 61–70; March, 1941.
[4] U. A. Baranulko, "Temperature of the upper layers of the atmosphere," *Priroda*, vol. 34; May, 1948.
[5] J. E. Bost, F. T. Farmer, and J. A. Ratcliffe, "Studies of region E of the ionosphere," *Proc. Roy. Soc.*, vol. A164, pp. 96–116; February, 1938.
[6] R. C. Colwell, "Atmospheric conditions and the Kennelly-Heaviside layer," *Nature*, vol. 130, pp. 627–628; October, 1932.
[7] R. C. Colwell, "Cyclones, anticyclones, and the Kennelly-Heaviside layer," Proc. I.R.E., vol. 21, pp. 721–725; May, 1933.
[8] R. C. Colwell, "Effect of thunderstorms upon the ionosphere," *Nature*, vol. 133, p. 948; June, 1934.
[9] E. Gherzi, "Ionospheric reflections and weather forecasting for eastern China," *Bull. Amer. Met. Soc.*, vol. 27, pp. 114–116; March, 1946.
[10] V. N. Kessenikh and H. D. Bulatov, "The continental effect in the geographic distribution of the electron concentration in the F_1 layer," *Compt. Rend. Acad. Sci.* (URSS), vol. 45, pp. 234–237; Nov., 1944.
[11] D. F. Martyn, "Atmospheric pressure and the ionization of the Kennelly-Heaviside layer," *Nature*, vol. 133, pp. 294–295; February, 1934.
[12] T. G. Mihran, "A note on a new ionospheric-meteorological correlation," Proc. I.R.E., vol. 36, pp. 1093–1096; September, 1948.
[13] I. Ranzi, "Causes of ionization in the upper atmosphere," *Nature*, vol. 130, p. 545; October, 1932.
[14] H. Flohn and R. Penndorf, "The stratification of the atmosphere, *I*," *Bull. Amer. Met. Soc.*, vol. 31, pp. 71–78; 1950.
[15] CRPL Series F., "Ionospheric Data," CRPL, Washington, D. C.; 1945–1947.

Institute News and Radio Notes

Color Television Discussed at Electronics Conference

Chairman Wayne Coy of the Federal Communications Commission gave the reasons back of the recent decisions regarding color television in speaking at the opening luncheon of the 1950 National Electronic Conference held on September 24–27, at the Edgewater Beach Hotel, Chicago, Ill.

Total registration at the conference was 2,350, well above the figure for the 1949 conference. Some 60 exhibitors occupied all of the space used in previous conferences, and overflowed into the main corridor of the hotel.

"Twenty-Five Years of Progress," was the theme. Many exhibits, including old as well as new equipment, were shown. The exhibit of the IRE Chicago Section was presented in connection with its Silver Anniversary Celebration.

All of the eighteen technical sessions during the conference were well attended. *Proceedings* of the Conference will be published early in 1951. Most of the 60 technical papers presented have already gone to the editors. The volume may be ordered from the National Electronics Conference, Inc., 852 E. 83 St., Chicago 19, Ill.

Speakers at the meeting included Titus Le Clair, national president of the AIEE, who introduced E. A. McFaul, formerly of Northwestern University, who spoke on the subject, "Is The Engineer Slipping?"

The major social event was the Old Timers Dinner in the hotel ballroom at which the IRE Chicago Section was host to many outstanding figures in the electronics industry who had been active and prominent in the field for twenty-five years or more. W. L. Everitt, Dean of Engineering, University of Illinois, introduced the honored guests.

The sponsor of the Wednesday luncheon was The Institute of Radio Engineers. Raymond F. Guy, IRE president and manager of radio and allocation engineering of the National Broadcasting Company, introduced John V. L. Hogan, who spoke on the subject, "What's Behind IRE?" Mr. Hogan prominent inventor in the radio and electronics field, was one of the organization's founders. He recounted its early history and outlined plans for the future.

The 1951 National Electronics Conference is scheduled for October 22, 23, and 24 and will be held at the Edgewater Beach Hotel, Chicago, Ill.

Peter Mole Is Elected New President of SMPTE Group

Peter Mole, president of the Mole-Richardson Co., Hollywood, Calif., was elected president of the Society of Motion Picture and Television Engineers at a meeting of the Board of Governors which preceded the opening of the organization's 68th semiannual convention at Lake Placid.

Discuss Color Television

From left to right: Nathan Cohn, President of NEC and Wayne Coy, FCC Chairman at National Electronics Conference.

Others who will assume office on January 1 are: Herbert Barnett, General Precision Laboratories, Pleasantville, N. Y., as executive vice-president; and John G. Frayne of the Westrex Corp., Hollywood, Calif., as editorial vice-president. Re-elected to office were William C. Kunzmann as convention vice-president and Robert M. Corbin as secretary.

Other officers of The SMPTE include Fred T. Bowditch, engineering vice-president; Ralph B. Austrian, financial vice-president; and Frank Cahill, treasurer.

The new Board of Governors of the SMPTE who will take office on January 1, include: William B. Lodge, CBS; Oscar F. Neu, Neumade Products Co.; Frank E. Carlson, GE, Nela Park; Malcolm G. Townsley, Bell and Howell; Thomas T. Moulton, 20th Century Fox, Hollywood; Norwood L. Simmons, Eastman Kodak; and Lloyd Thompson, Calvin Co.

IRE/AIEE/RDB
Joint Conference on
Electron Tubes for Computers
Haddon Hall Hotel
Atlantic City, New Jersey
December 11 and 12, 1950

Monday, December 11

9:30 A.M. Computer Experience with Electron Tubes.
1:30 P.M. Electron Tube Problems.
8:00 P.M. Special Purpose Computer Tubes.

Tuesday, December 12

9:00 A.M. Tube Manufacture and Crystal Diode Experience.
1:00 P.M. Williams-Type Storage.

Monmouth Subsection Sponsors Program of Community Service

The Monmouth Subsection of the New York Section of The Institute of Radio Engineers is sponsoring a number of interesting projects as a part of its Community Service program for the year 1950–1951. Included in its program are the following activities: professional assistance in civil defense planning and operating; reconditioning of donated television and radio receiving sets for installation in hospitals and welfare agencies for the use of patients and inmates; courses for laymen in popular electrical subjects, such as "Electricity in the Home," as a part of existing adult education programs; participation in the career counseling program of high schools and junior colleges, featuring vocational guidance in the field of radio electronics; liaison with other professional groups, such as doctors and lawyers, in matters of general interest to the community and of mutual interest to two or more professions; and newspaper columns or articles on the popular aspects of television and related subjects of general interest.

Included on the local IRE Community Service Committee are G. L. Van Deusen of RCA Institute; S. D. Robertson and L. E. Hunt, Bell Telephone Laboratories; H. S. Bennett, Watson Laboratories; John L. Slattery and A. Enurian, Evans Signal Laboratories; George Trad and J. D. Winer.

NOTICE

Effective January 1, 1951, the Student dues will be $5.00 per year. Payments at the old rate of $3.00 will be accepted through December 31, 1950. All payments received thereafter will be at the new rate.

25 Years of IRE in Canada

1925—Canadian IRE Section Formed

The IRE was introduced to Canadian radio engineers on October 2, 1925, in Toronto, when a Canadian Section was organized by C. L. Richardson, the first Chairman, who was elected along with Dugald Hepburn, Vice-Chairman, W. J. Hevey, Secretary, C. C. Meredith, Assistant Secretary, and G. F. Eaton, Treasurer. From this beginning with some 53 members and guests present, IRE in Canada has grown constantly until there are now 958 Fellows and members of all grades. Sections and Subsections have been formed in six additional cities, and student branches at the Universities of Alberta and Toronto. Much credit for the advancement of IRE in Canada goes to Ralph A. Hackbusch, Fellow, 1937, who was Chairman of the Toronto Section, 1932–1933; Director, 1938; Vice-President, 1944; Director-At-Large, 1945 and 1946.

C. L. Richardson
Chairman, Canadian Section
1925–1926

1950—Present Canadian Council IRE

R. G. Anthes
Education

C. A. Norris
Vice Chairman and Membership

F. S. Howes (F'50)
Past Chairman

F. H. R. Pounsett (F'47)
Regional Director
Chairman Canadian Council
1949–1950

R. C. Poulter
Professional Status

G. J. Irwin
Regional Convention

❖

A. H. Sievert
Publicity

The Canadian Council of the IRE was formed in 1945 to co-ordinate the activities of the various Canadian Sections in National matters. This plan formed the basis of the organization now in effect in the eight IRE regions. Despite the obstacles of distance, the Canadian Council has performed its function well.

J. C. R. Punchard
Secretary

❖

C. G. Lloyd
Papers and Silver Anniversary

Present Canadian Council IRE (cont'd.)

T. I. Millen
Chairman, 1950–1951

C. G. Lloyd
Chairman, 1949–1950

TORONTO SECTION, 1925

J. C. Bernier
Chairman, 1950–1951

A. B. Oxley
Chairman, 1949–1950

B. R. Tupper
Chairman, 1950–1951

A. H. Gregory, Chairman,
Organizing Committee

MONTREAL SECTION, 1937

The Montreal section was organized by a group which had previously helped to organize the Canadian (now Toronto) Section twelve years earlier. A. M. Patience was the first Chairman.

VANCOUVER SECTION, 1950

The newest Canadian section has just been formed under the organizing hand of A. H. Gregory and the Chairmanship of B. R. Tupper. This fills a long expressed need for IRE on Canada's west coast.

J. T. Henderson
Chairman, 1950–1951

A. W. Y. Desbrisay
Chairman, 1949–1950

S. G. L. Horner
Chairman, 1950–1951

R. D. Cahoon
Chairman, 1949–1950

OTTAWA SECTION, 1944

Engineers and scientists in the Armed Forces Headquarters and the National Research Council formed the Ottawa IRE section, with F. P. Park as acting Chairman, followed by Col. W. A. Steele.

WINNIPEG SUBSECTION, 1945

Formed as a subsection of the Toronto Section under W. A. Cole as chairman, this group now plans to apply for full Section status. This is an indication of its growth and activity in the years since its formation.

F. P. Kehoe
Chairman, 1950–1951

G. W. Foster
Chairman, 1949–1950

L. R. Harris
Chairman, 1950–1951

A. H. Sievert
Chairman, 1949–1950

LONDON, ONT. SECTION, 1944

With Professor G. A. Woonton as the Chairman, the first London Section meeting achieved distinction by viewing its charter on a local television hook-up. From this beginning, it too has constantly grown.

HAMILTON SUBSECTION, 1947

Also a subsection of the Toronto section, this group was formed under the Chairmanship of T. S. Farley. It was then and has continued since as one of the most active IRE groups in Canada.

Technical Committee Notes

The Standards Committee, under the Chairmanship of J. G. Brainerd, held a meeting on September 14, 1950, at which reports on the activities of the various Subcommittees of the Standards Committee were given by their respective Chairmen. The Technical **Committee on Nuclear Science has been disbanded** in view of the fact that work previously done by this Committee is now handled by the IRE Professional Group on Nuclear Science. . . . **The Video Techniques Committee held a meeting on** October 2, 1950, J. E. Keister, Chairman, presiding. . . . **R. L. Garman, of Subcommittee 23.2** Utilization; Including Video Recording, has prepared a paper on "Video Utilization; An Introduction and Definition of the Art" for publication in the Proceedings. H. J. Schlafy, another member of this Subcommittee, is the author of a paper which will also be published in Proceedings of the I.R.E., entitled, "Comparative Factors of Picture Resolution in Television and Film Industries." A proposed Standards on Television: Methods of Measurement of Electronically Regulated Power Supplies, prepared by the Video Techniques Committee has been approved by the Standards Committee. Chairman Keister reported on the Joint IRE Committee for Television. The letters IRS stand for IRE, RTMA and SMPTE. The Committee's Chairman is A. G. Jensen of the Bell Telephone Laboratories. The IRE members of this Committee are M. W. Baldwin, Jr., and R. L. Garman. . . . A meeting of **the Circuits Committee** was held on September 15, W. N. Tuttle, Chairman, presiding. Comprehensive reports of the activities of the Subcommittees of the Circuits Committee were given by the respective Chairmen. . . .

Please note that the **Conference on Electron Tubes for Computers** previously scheduled to be held in Washington, D. C., **will be held** in Haddon Hall on **December 11–12, 1950,** Atlantic City, N. J. . . . A meeting of the **Antennas and Waveguides Committee** was held on September 12, under the Chairmanship of A. G. Fox. . . . Work is progressing towards the **publication of the revision of the present IRE Master Index of Terms.** . . . The **IRE will participate in the Annual Convention of the Institute of Aeronautical Sciences** which will be held in New York, N. Y., the last week in January, 1951. . . . A **joint IRE/IAS Committee** is organizing a full-day program of approximately eight papers to be devoted to "Electronics in Aviation." As soon as details for this event are formulated they will be announced. . . . **The Navigation Aids Committee held** a meeting on September 22, under the Chairmanship of P. C. Sandretto. . . . **The Joint Technical Advisory Committee, under** the Chairmanship of J. V. L. Hogan, held a meeting on September 14. The JTAC has prepared a supplementary statement which was submitted to the Federal Communications Commission in October. . . . E. K. Gannett, Technical Editor of Proceedings of the I.R.E., has been appointed to serve as IRE Representative on the Subcommittee on Abbreviations of the ASA Sectional Committee Z10.

IRE Board of Directors Announces 1951 Awards

The Board of Directors of The Institute of Radio Engineers, upon the recommendation of the Awards Committee, has named the recipients of the annual awards for 1951. Presentation of the awards will be made by the President at the annual banquet, a feature of the 1951 IRE National Convention to be held on March 19–22 at the Waldorf-Astoria Hotel and Grand Central Palace in New York, N. Y.

The awards will be presented to the following: Medal of Honor, V. K. Zworykin; Morris Liebmann Memorial Prize, R. B. Dome; Browder J. Thompson Prize, A. B. MacNee; Harry Diamond Memorial Award, M. J. E. Golay; Editor's Award, W. W. Harman.

Fellows, highest membership grade in IRE, will also be announced at that time.

Calendar of COMING EVENTS

IRE-AIEE Conference on Electron Tubes for Computers, Atlantic City, N. J., December 11–12

AAAS Annual Meeting, Cleveland, Ohio, December 26–30

AIEE-IRE-NBS High Frequency Measurements Conference, Hotel Statler, Washington, D. C., January 10–12

AIEE Winter General Meeting, Hotel Statler, New York, N. Y. January 22–26

1951 IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y., March 19–22

IRE Southwestern Conference, Dallas, Texas, April 20–21, 1951

1951 Annual Meeting of the Engineering Institute of Canada, Mount Royal Hotel, Montreal, May 9–11

1951 IRE Technical Conference on Airborne Electronics, Biltmore Hotel, Dayton, Ohio, May 23–25

1951 IRE West Coast Convention, San Francisco, Calif., August 29–31

Bell System Will Expand Its Television Network Channels

The Long Lines Department of the American Telephone and Telegraph Company made a 50 per cent increase on September 30 in the number of cities connected in its television networks.

This expansion, the largest since the eastern and midwestern TV networks were joined in January, 1949, will add 14 cities to the present 28-city networks and, for the first time, carry live network television as far south as Jacksonville, Fla., and as far west as Omaha, Neb.

The route extensions will give network service to 19 more television stations covering areas populated by about 12 million people. The present Bell System network serves 54 stations in areas populated by about 60 million people, according to estimates in the industry. Latest estimates indicate that on September 30 better than 80 per cent of the nation's seven and one-half million television sets will be in range of live network broadcasts.

Five of the new network cities are in the southeast: Greensboro and Charlotte, N. C.; Jacksonville; Atlanta, Ga.; and Birmingham, Ala. Two are in the central area: Indianapolis, Ind. and Louisville, Ky.; and seven in the west central area, including Rock Island, Ill., Davenport and Ames, Ia., Omaha, Kansas City, Mo., and Minneapolis and St. Paul, Minn.

IRE Vancouver Section Formed; Toronto Celebrates 25th Year

At its September meeting the Board of Directors approved the establishment of the new Vancouver Section, as the fifty-seventh IRE Section, to include the Provinces of Saskatchewan, Alberta, British Columbia, and the Yukon Territory. The addition of the Vancouver Section brings to a total of five the number of Sections in Canada.

The territory comprising the Vancouver Section was relinquished by the Toronto Section, which this month is celebrating the Silver Anniversary of its founding as the first IRE Section in Canada and one of the first seven Sections established by the Institute.

Western Union Company Has Developed Amplifier Cable

The Western Union Telegraph Company has recently revealed the development of the world's first submerged transatlantic cable amplifier. As the result of the invention the annual capacity of Western Union's cable system will be increased by more than one hundred million words and will have far-reaching effects in greatly reducing the frequency demands in the crowded global radio spectrum. The first amplifier will be inserted in a transatlantic cable 1,800 feet down, at the bottom of the ocean, northeast of Newfoundland in July, and at least double the speed of that cable.

The 3-stage amplifier, developed under the direction of H. P. Corwith (M'26–SM'43), vice-president of Development and Research, will be equipped with three complete sets of vacuum tubes. An electrically operated switch, controlled from a shore station, will change tubes in the event of tube failure.

While in recent years a few submerged telephone repeaters have been laid in short cable, this is the first amplifier developed for the cables now spanning the Atlantic.

Industrial Engineering Notes[1]

Television News

Color Television Inc., has petitioned the FCC for a "reopening of the record" and for a further "hearing" on color TV matters. CTI told the FCC it has "invented a wholly new method of transmitting and receiving signals capable of producing television pictures in full color." "This new method," CTI said, "is unique and is believed to be superior to any other color television system heretofore suggested to the Commission in connection with the development and promulgation of standards" for commercial color television. Labelled "uniplex," the new system was said to be fully compatible with present black-and-white television. Detail is transmitted in all colors, CTI said, with the resolution "corresponding with black and white." CTI said the "uniplex" receiver circuit requirements are no more critical than for black-and-white reception. It will accurately reproduce monochrome transmission, the petition said, and CTI receivers using the new system will function with any presently disclosed direct-view color tube, requiring fewer additional receiving tubes over black-and-white sets than any color TV system so far proposed, and without loss of fidelity. Conversion of standard black-and-white sets to color, CTI said, is practical through the use of a small and inexpensive unit plus a direct-view color tube. This small unit was not described. CTI stated that it would require about three dates to present testimony on the new system. . . . Television receiver production reached a new peak of 702,287 sets in August, bringing the industry total for eight months to 4,146,602 TV sets in August, according to RTMA industry estimates. The industry's output through August was 1.1 million units higher than for the entire year, 1949. . . . Radio set production was estimated at 1,203,447 units in August and 8,750,965 during the eight-month period. The August report both for radio and TV covers only four weeks, or through August 25. RTMA estimates are for both members and nonmembers.

Radio and Television News Abroad

The Netherlands plans to inaugurate television service for the public early next year, according to information received by the U. S. Department of Commerce. Present plans call for the establishment of six transmitters the first of which is to be located at Lopik to serve The Hague, Amsterdam, and Rotterdam areas. The Dutch transmission will utilize 625 lines. . . . The market in Honduras for radios, tubes, and parts, although small, is increasing, the Department of Commerce has reported. In the fiscal year ended June 30, 1949, the value of imports of radio equipment was $240,907, compared with $182,471 in the corresponding period of 1948. . . Annual production of radio sets in Uruguay is estimated at 35,000 to 40,000 units, according to a report to the U. S. Department of Commerce. Many of the components used in radio assembly are of U. S. origin, although variable condensers, as well as speakers and transformers, are now produced locally. The trend in the industry, is, however, toward self-sufficiency in all major components except capacitors and resistors. The United States' share of the market for radios declined from 76 per cent in 1948 to 34 per cent in 1949, while the share of Great Britain increased from 11 per cent to 40 per cent. Holland and Denmark accounted for 19 per cent of the imports in 1949. The United States' share of the radio parts market declined from 85 per cent in 1948 to 57 per cent in 1949, while Great Britain's proportion increased from 4 to 33 per cent. These shifts are attributed to the dollar shortage, and do not reflect any lack of demand for United States products, the Commerce Department said.

Munition Board Announces Security Procedure Check

The Munitions Board has established uniform policies, procedures, and standards to aid industry in clearing facilities and personnel to handle classified matter in dealing with the Army, Navy, or Air Force on military contracts.

Regulations covering the uniform procedure have been issued to the armed services. A central security file has been established to maintain data on all individuals, organizations, facilities, factories, etc., that have been cleared by the military departments.

The new regulations are designed to eliminate past duplications necessitated by requiring plants to fill out forms for some bureaus in the Navy, another for the Air Force, and still another for the Army. Now one form only will be required for all.

Statistics

A record production of television receivers was set in August by the radio-television manufacturing industry, according to estimates projected from RTMA member-company production reports. RTMA estimates show a total of 702,287 TV receivers manufactured by the industry during a four-week period ending August 25. Radio set production was also at high level with 1,203,447 being produced during the month. During the fourth week 187,891 TV sets are estimated by RTMA to have been manufactured. . . . Rectangular TV picture tubes accounted for 47 per cent of the July cathode-ray tube sales to set manufacturers, according to member company reports to RTMA. Due to the vacation shutdown of manufacturing plants, July sales of cathode-ray tubes of 16 inches and larger in size, picture tubes 15 inches and less accounted for only 15 per cent of the July sales, while tubes 19 inches and larger amounted to slightly more than 11 per cent.

Committees Agree on 50 Microvolts as Goal in FM Radiation Reduction

Members of the R6 Committee on FM Receivers and the R15 Committee on Radio Interference, Receiver Section, of the RTMA Engineering Department, on Tuesday, September 12, adopted a resolution recommending that by June 30, 1951, all FM receivers in production comply with a radiation limitation of 50 microvolts per meter at 100 feet.

The committee also adopted a resolution recommending that standards also be adopted, following appropriate early study, for television receivers and radiation limits were suggested of 50 microvolts per meter at 100 feet on channels 2 through 6, and 150 microvolts per meter at 100 feet on channels 7 through 13.

Curtis Plummer, FCC Chief Engineer, while not committing the Commission to the acceptance of any value, commended the industry for the progress that has been made by the committees and urged the immediate adoption of the recommended standard in the production of FM sets.

Earlier the industry engineers brought out the lack of uniform standards for measuring radiation, and it was agreed that FCC engineers will co-operate with industry engineers in tests to be made in Philadelphia, Chicago, and Washington. An IRE committee is working on standards for such measurements.

New FM Service Requested by Multiplex Corporation

The Multiplex Development Corporation petitioned the FCC to change its rules governing FM broadcasting to permit "multicasting" by FM stations. The company has been conducting developmental broadcasts and experiments since June 5 under a Commission developmental license. The plan would permit FM stations to utilize their frequencies for a "supplementary" broadcast service. The company claims this is possible without interference occurring to other FM broadcasts.

Public service uses of the new method were cited, including use of "multicasting" by civil defense authorities. The proposed method would also provide a service for transit radio and storecasting, the petition said.

States Cannot Censor Television Films

The Third United States Court of Appeals has held that state boards of censors have no right to censor motion-picture films to be used on television programs. The unanimous ruling stated that Congress, and not the individual states, can regulate television broadcasts.

Record Factory Lay-Offs in July

The U. S. Department of Labor has reported that the lay-off rate in July in the nations' factories declined to 6 per 1,000 employees, the lowest level in four years. The stepped-up rate of hiring which was reached in June was maintained in July, the Department said. Factories hired workers at a rate of 46 for every 1,000 employees on the payroll.

[1] The data on which these NOTES are based were selected by permission from *Industry Reports*, issues of September 1, September 8, September 15, September 29, published by the Radio-Television Manufacturers Association, whose helpful attitude is gladly acknowledged.

Kahn Re-elected President of Radio Parts Meeting

Jerome J. Kahn, president of Standard Transformer Corp., was re-elected president of the Radio Parts and Electronic Equipment Shows, Inc., at the annual meeting at the Greenbrier Hotel, White Sulphur Springs, W. Va.

Samuel J. Spector, of Insuline Corp. of American, was chosen vice-president; Lew Howard, Triad Transformer Mfg. Co., secretary; and Charles A. Hansen of Jensen Mfg. Co., treasurer.

The board of directors voted to hold a three-day show May 21, 22, and 23 at the Hotel Stevens, Chicago, Ill., with booths in Exhibition Hall and display rooms on the fifth and sixth floors open from 10:30 to 6 P.M. daily.

Accelerate Crystal Processing

The Signal Corps has begun an expedited crystal processing program because of the urgent requirements caused by the current international situation it has been announced. Approximately four million crystals will be processed within the next ninety days, with the work load equally distributed between the New Cumberland General Depot, Pa., and the Decatur Signal Depot, Ill.

United States Plans to Purchase Radios for Possible Use Abroad

The Department of State has revealed that discussions have been held with four radio manufacturers on the purchase of 200,000 small radios for possible use behind the Russian "iron curtain." The plan is aimed at increasing the number of listeners to the Voice of America program.

A supplemental appropriations bill now before Congress contains $2,860,000 in funds for the purchase of such sets in addition to $41,288,000 for new VOA transmitting stations.

Manufacturers interested in the project, according to the State Department, are RCA International; General Electric International; Pilot Radio Corp.; and Emerson Radio and Phonograph Corp. The first three concerns are understood to have submitted models, and Emerson was said to have made a price quotation.

The type of set needed to cover the standard broadcast band and all the international bands up through 22 Mc. Discussions so far have involved battery-operated sets.

Top Government Officials Reassure NAB on Its Plans

Two important Government officials, FFC Chairman Wayne Coy and John Steelman, assistant to the President, have assured the nation's broadcasters through the National Association of Broadcasters that there were no plans presently contemplated to restrict their activities during the current emergency.

Dr. Steelman emphasized that American radio and television broadcasters could expect no controls beyond those self-imposed ones that were employed during the war.

IRE People

R. G. E. Hutter (SM'46), head of the electronics research section of the Physics Laboratory, Sylvania Electric Products Inc., Bayside, L. I., N. Y., has been appointed adjunct professor at the Brooklyn Polytechnic Institute, where he will conduct classes in electron tube theory and electron optics.

R. G. E. Hutter

A native of Berlin, Germany, Dr. Hutter was a graduate student in physics and mathematics at the University of Berlin from 1930 to 1936. From 1936 to 1938 he served as a research physicist in the Telefunken transmitter laboratories, and in 1938 and 1939 was chief engineer of station KZIB in Manila, P. I. During 1940 and 1941 he was a graduate student in communication engineering and physics at Stanford University serving, until he received the Ph.D. degree in 1944, as a research associate in the University's Division of Electron Optics.

Since then Dr. Hutter has been associated with the Physics Laboratories of Sylvania Electric. He is also a member of the American Physical Society and Sigma Xi.

His course in electron tube theory will include an analysis of the basic operating conditions for microwaves.

❖

Merle A. Tuve (F'45), of the Carnegie Institution, Washington, D. C., has been awarded a Howard N. Potts Medal by the Franklin Institute for the proximity fuze which helped attain many decisive victories in World War II.

The citation accompanying the award reads: "In recognition of the scientific insight exhibited in the conception of the TV Proximity Fuse and of the administrative ability and practical good judgment shown in the supervision of its development and engineering design."

Dr. Tuve was born in Canton S. D. He was graduated from the University of Minnesota as an electrical engineer in 1922 and received the M.A. degree the following year. In 1926 Johns Hopkins awarded him the Ph.D., and honorary D.Sc. degrees were given him by Case, Kenyon, and Williams Colleges in 1948 and 1949. Before joining the staff at Carnegie Institution in 1926, he was physics instructor both at Princeton University and at Johns Hopkins.

Among the honors held by Dr. Tuve are: Commander, Order of the British Empire; the AAAS prize in 1931; Presidential Medal for Merit, 1946; The Research Corporation award, 1947; the John Scott award, Philadelphia; and the Comstock Prize of the National Academy. He is a Fellow of the American Physical Society, and a member of the American Philosophical Society, National Academy of Sciences, American Academy of Arts and Sciences, American Geophysical Union, Phi Beta Kappa, Tau Beta Pi, and Sigma Xi.

Dr. Tuve is editor of the *Journal of Geophysical Research* and contributes papers to the *Physical Review* and other scientific journals regarding nuclear physics, geophysics, and biophysics. At present he is doing research relative to the crust of the earth and its early geological history.

❖

John E. Allen (A'23–SM'45), chief of tests for the Pennsylvania Water and Power Company and the Safe Harbor Water Corporation, and known nationally for his contribution to the progress of electrical engineering, died in August at Lancaster, Pa. Mr. Allen, who was 57 years old, had been ill for about three months.

He was best known for his work in developing the high-frequency fault locator. He was a joint recipient in 1935 of a first prize award by the Edison Electric Institute for this work. Another of his inventions was a high-speed frequency indicating meter which permitted instantaneous perception of alternating-current frequency.

Among his other research accomplishments were contributions to the reduction of the effects of lightning on transmission lines; the improvement of governors for hydro turbines; the measurement of radio field strength preliminary to the design of a space radio system; and the design and construction of equipment for carrier current and land wire telephone systems.

He was also a member of the AIEE in which organization he was a Fellow, and was a member of the National Association of Corrosion Engineers, the Instrument Society of America, and the American Association for the Advancement of Science.

❖

John T. Wilner (A'37–M'46–SM'48), engineering director of radio stations WBAL and WBAL-TV, has been elected vice-president in charge of engineering of Hearst Radio, Inc. He formerly was engineer-in-charge of CBS television development.

Mr. Wilner is one of the country's foremost authorities on television transmission techniques. He is the inventor and designer of numerous video circuit refinements, including an electronic horizontal wipe.

IRE People

O. W. Pike (A'26–M'29–SM'43–F'51), manager of engineering in the tube divisions of General Electric Co.'s electronics department, died on October 7 at Ellis Hospital in Schenectady, N. Y. He was 51 years old. Mr. Pike became associated with General Electric Company in 1920.

O. W. PIKE

Mr. Pike, who was graduated from the University of New Hampshire with the B.S. degree in electrical engineering, joined the company as a student engineer. In 1922 he was transferred to the research laboratory to do developing work on small transmitting tubes. He was placed in charge of development of low power tubes in 1924, and later on assumed responsibility for the development of gas and mercury vapor tubes.

Mr. Pike was appointed designing engineer when the vacuum-tube department was formed in 1930. He was then placed in charge of the design and development of both industrial and radio tubes, and when the tube division was created in 1943 he was then named division engineer.

He was chairman of the Joint Electronic Tube Engineering Council when it was formed and continued as a member until his death.

He was named to receive the 1950 Radio Fall Meeting Plaque to have been given during the meeting on October 30–November 1, for his work in organizing JETEC.

❖

I. J. Melman (A'43) has been appointed head of the advanced development division of Air King Products Co., Inc., manufacturers of radios, wire recorders, and television receivers. He will be in charge of advanced development as well as television research for Air King.

Mr. Melman formerly was associated with Micamold Radio Corporation, and was senior instructor at the Air Forces Communications School at Scott Field and Yale University. From January, 1945, until his present appointment he was a member of the technical staff of the RCA Industry Service Laboratories.

Dundas P. Tucker, Captain, U. S. Navy (A'36–SM'46) has been appointed Director of the Navy Electronics Laboratory, located on Point Loma near San Diego, Calif. This Laboratory is responsible for a large portion of the research and development work of the Navy Bureau of Ships in radio, radar, acoustics, and allied fields. His previous assignment was Director of the Electronic Design and Development Division, Navy Bureau of Ships.

Captain Tucker's electronics activities cover a span of more than thirty years. He received the B.S. degree from the U. S. Naval Academy in 1925, and the M.A. degree from Harvard University in 1934.

During World War II Captain Tucker was responsible for the radar and guided missiles program of the Navy Bureau of Ordnance. He was the originator of the Navy's "Bat," the first automatic guided missile to see regular service use. He was awarded the Legion of Merit for these war services.

❖

Hector R. Skifter (A'31–M'36–SM'43), president of Airborne Instruments Laboratories, Inc., Mineola, L. I., N. Y., has been appointed chairman of the Committee on Navigation of the Department of Defense Research and Development. **Norman L. Winter** (A'47–M'47), assistant to the vice-president and general sales manager, Sperry Gyroscope Co., Great Neck, L. I., N. Y., has been appointed a member of the committee.

Dr. Skifter, who has been a member and vice-chairman of the committee since its formation in June, 1948, has been serving as acting chairman for the past six months. During World War I he was associate director, Airborne Instruments Laboratory of Columbia University, Division of Research.

Dr. Winter has been associated with the Research and Development Board since its formation, serving as executive director of its Committee on Electronics from its formation in August, 1946, until May, 1949, and as a consultant since then, He served as a colonel in the Air Force during World War II and his last position was as Chief, Plans Section, Electronic Subdivision, Engineering Division, Air Materiel Command. He has been with Sperry Gyroscope since he left the Committee on Electronics.

Donald G. Fink (A'35–SM'45–F'47) is another member of the committee, while **W. J. Merchant** (SM'47) is executive director of the Committee Secretariat which carries on the work of the part-time committee.

❖

Vladimir K. Zworykin (M'30–F'48) has been awarded the 1950 Progress Medal of the Society of Motion Picture and Television Engineers, the highest honor granted by the Society for significant scientific contributions in a new field. His basic research and developments have helped make television a present-day reality.

Dr. Zworykin received the award at the 68th semiannual convention of the SMPTE at Lake Placid, N. Y. He is vice-president and technical consultant of the RCA Laboratories Division, Radio Corporation of America.

❖

John H. Howard (SM'50) has been named a member of the staff of the Research Division of the Burroughs Adding Machine Company in Philadelphia, Pa. Until recently he had been a consultant in the field of electronic control systems.

JOHN H. HOWARD

Mr. Howard, who holds the B.S. degree in electrical engineering from Kansas State College, received an appointment in 1935 as a research associate at the Massachusetts Institute of Technology, where he received the M.S. degree in electrical engineering in 1939.

After completing three years of service with the U. S. Navy in 1946, he was Director of Development at Engineering Research Associates and was later associated with the Sperry Gyroscope Company.

He is also a member of the AIEE, Sigma Xi, and Phi Kappa Phi.

❖

Charles E. Apgar, a pioneer radio operator, died recently at his home at Westfield, N. J., at the age of 85 years. During the first World War Mr. Agpar aided the United States government in detecting subversive messages from a German radio station located at Sayville, L. I., N. Y. He recorded code messages from the station which was said to be broadcasting information to German submarines on the movements of neutral ships, and caused the government to seize the station.

Mr. Apgar, who was born in Gladstone, N. J., attended Wesleyan University. He was associated with the New York Life Insurance Company, and was a salesman before he became an executive for the New York brokerage firm of Spencer Trask and Company. His hobby was astronomy and he wrote for the publication of the Royal Canadian Astronomical Society, and other periodicals.

Mr. Apgar joined The Institute of Radio Engineers as an associate in 1913, but later resigned his membership.

IRE People

Norman E. Wunderlich (M'49) has been elected vice-president and general manager of the Link Radio Corporation, N. Y., and will be in charge of all company activities. **Frederick T. Budelman** (A'41) has been named vice-president in charge of engineering and research, and as assistant to Mr. Wunderlich.

Since last July Mr. Wunderlich has been associated with Link Radio Corp., in the establishment of a Chicago office and service center, and in organizing a sales-engineering force throughout the Middle West.

He has been active in the radio and electronic industry for over 30 years. Previously, he had been connected with the administrative, executive, and engineering management of Motorola, IT&T Corp., and Federal Telephone Radio Corp., and was a co-owner of the Rauland Corp., director of engineering and research for the Victor Talking Machine Co. and RCA Victor Co., vice-president of Lear, Inc., and founder and owner of Wunderlich Radio Corp.

❖

Sam Norris (A'47) has been elected president of the Amperex Electronic Corp., Brooklyn, N. Y. Previously, he had been executive vice-president.

He has been closely associated with the growth of Amperex, which for over twenty years has been a leading manufacturer of power and transmitting tubes and is a pioneer in the ultra-high-frequency field. Its newest developments include a new-type rotating anode X-ray tube, geiger counters, magnetrons, and power tubes.

Mr. Norris was graduated from Cornell University with the B.A. degree in 1927.

❖

John H. Ganzenhuber (A'42), formerly manager of broadcast sales for Western Electric Co., has been appointed vice-president in charge of the sales and product development of Standard Electronics Corp., wholly owned subsidiary of Claude Neon, Inc. He will supervise Standard's national sales program and be responsible for equipment development. His work will have particular emphasis on the television broadcast field.

J. H. Ganzenhuber

In addition to handling Western Electric's broadcast sales operations, Mr. Ganzenhuber took an active part in Western Electric's radar program for the Armed Forces during the war. Prior to this he was field sales engineer and district manager of broadcasting sales for Graybar Electric Co. for nine years. This latter organization will distribute Standard Electronics' entire line of television, AM, and FM broadcast equipment.

Mr. Ganzenhuber, who was born on September 19, 1909, was graduated from the University of Southern California in 1933 with the B.S. E. E. degree.

❖

Adriano A. Pascucci (SM'48), director of the research laboratories, Radio Hispano-Suiza, Barcelona, Spain, has been awarded, together with H. W. Stawski, the first "Bosone's Prize" at the annual general Board of Directors' meeting of the Associazione Elettrotecnia Italiana in Milano, Italy, in April. The award will be given annually by the Associazione Elettrotecnia Italiana for outstanding achievements in the field of experimental research on dielectrics.

Dr. Pascucci's and Dr. Stawski's contributions to the knowledge of dielectric properties of ceramic materials include development and experimental tests on ceramic titanates, and a system of frequency modulator realized with a titanate nonlinear capacitor, presented in October, 1947, at the international congress for the celebration of the 50th anniversary of Marconi's discovery of radio, which was held in Rome, Italy, from September 28 to October 5.

In 1948 Dr. Pascucci joined the Radio Hispano-Suiza as research director, where he is now engaged in Industrial Television research. He is also a member of the Acoustical Society of America, the American Institute of Physics, and the Associazione Elettrotecnica Italiana.

❖

William R. Spittal (A'40), former general manager and vice-president of Ferranti Electric Inc., New York, N. Y., recently opened a new plant, known as the Highland Engineering Co., 32 Holman Blvd., Hicksville, N. Y., for the manufacture of transformers, inductors, rectifiers, power supplies, and the like for industrial and electronic fields.

Mr. Spittal is a graduate of the University of Toronto, receiving the B.A.Sc. degree in 1927 and the electrical engineering degree in 1933.

❖

William S. Dawson (A'49), formerly with Headquarters, Airways and Air Communications Service, Washington, D. C., has arrived in Tokyo for assignment to Headquarters, 1808th AACS Wing. He has been assigned duties as Weather Communications Advisor in his new organization.

He will make frequent field trips all over the Far East area, "trouble shooting" weather communications facilities. In Washington Major Dawson was Facsimile Project Officer for the AACS.

G. F. Callahan (A'39) has been appointed to a supervisory position in General Electric's cathode-ray tube division. A native of Elk Point, S. D., he was graduated from the University of Nebraska in 1924 with the B.S. degree in electrical engineering.

G. F. Callahan

In 1931 he joined the Ken-Rad Tube and Lamp Corporation at Owensboro, Ky., where he worked on the design of receiving tubes and served for four years as the Works Manager of the Bowling Green plant. Prior to that he had been engaged in the design, development, and manufacture of lamps and electronic tubes for several manufacturing concerns.

When GE acquired the Ken-Rad tube business, Callahan became active in the development of new miniature and cathode-ray receiving tubes. In 1948 he was appointed division engineer of the cathode-ray tube division with headquarters in Schenectady. When the cathode-ray tube plant was built in Syracuse, he moved to Electronics Park in the same capacity as division engineer.

❖

Milton A. Chaffee (M'49), field supervisor for Airborne Instruments Laboratory, Mineola, L. I., N. Y., who as an electronic expert was assigned by the U. S. Air Force to the Berlin Airlift to help establish its famous record in 1949, has been sent to the Far East to aid the USAF.

Mr. Chaffee has been with the Airborne Instruments Laboratory since 1945. Formerly he was associated with the Radiation Laboratory at MIT for three years. He is a graduate of the University of California, where he also did graduate work.

❖

New appointments at Bendix Radio Division, Bendix Aviation Corporation of Baltimore, Md., include that of **R. B. Moon** (A'42) who has been named assistant general sales manager. **J. W. Hammond** (A'39–SM'45) has been transferred to the Friez Instrument Division of Bendix Aviation Corp. as director of sales, and **R. L. Daniel** (M'46) will continue as manager of aviation radio sales, the company has announced.

❖

S. M. Decker (A'45) has been appointed assistant chief engineer of the Television Department of Air King Products Co., Inc., Brooklyn, N. Y., manufacturers of radios, wire recorders, and television receivers. Mr. Decker has been a prominent member of the radio field since 1939, and formerly was assistant chief engineer at Garod Radio Corp.

Books

Ionization Chambers and Counters by D. H. Wilkinson

Published (1950) by Cambridge University Press, 51 Madison Ave., New York 10, N. Y. 255 pages+6-page index+1x pages. 79 figures. 5½×8½. $4.50.

The advanced reader in the growing literature of nuclear science has available relatively few specialized books on the instruments of the field. Since the war many engineers have interested themselves in Geiger counters and ion chambers; thus this new book on the subject of these instruments will probably be eagerly sought, the more so because there are so few books of its type and because nuclear instrumentation is undergoing rapid development so that books in the field age quickly.

Engineers will not find Wilkinson's book aimed in their direction. Basically, the approach is one of developing the principles of Geiger counters and ion chambers. Much attention is given discussions which have a highly analytic texture so that the engineer will find he has to brush up on his physics to follow the arguments. The mathematics are quite straightforward and should present no difficulty. In spite of the theoretical nature of many pages in the book and the involved intricacies of the Geiger counter mechanisms, the reader will find that considerable technology has been woven into the treatment. This is most welcome especially as the author tends to strip away from Geiger counters the mystic ritual which so long attended their construction.

Professor Wilkinson has focused his treatment upon the principles of instrumentation, particularly upon the Geiger counter and ion chamber, to the exclusion of any description of the crystal counter and some of the more recent nuclear detection devices. None the less, the book is very complete and well organized with respect to the more conventional counting devices.

R. E. Lapp
Nuclear Science Service
Washington, D. C.

New Publications

"Bibliography of Electron Microscopy," by C. Marton, S. Sass, M. Swerdlow, A. Van Bronkhorst, and H. Meryman, (87 pages, 25 cents a copy) is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, 25, D. C. Remittances from foreign countries should be in United States exchange and should include an additional sum of one-third of the publication price to cover mailing costs.

The titles of the publications have been grouped in the following broad categories: Books, survey articles, instrumentation. electron optics, related instruments, and applications. Within each group the arrangement is chronological, and within each year it is alphabetical by author.

Each reference is consecutively numbered, and a special author index refers to these numbers. Only those papers having a direct bearing on electron microscopy and published before January 1, 1950, have been included. Semiscientific, popular accounts, and patent literature have been omitted.

Heaviside's Electric Circuit Theory by H. J. Josephs

Published (1950) by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 113 pages+2-page index+viii pages. 15 figures. 4×6¼. $1.25.

This book, one of the series of Methuen Monographs on Physical Subjects, although small physically (it will literally fit easily in the coat pocket) contains a worthwhile amount of material having to do with the methods introduced by Heaviside for solving the differential equations of electric circuits. It is by now becoming possible to take a reasonably dispassionate view of the field of the operational calculus without hindrance from the violent controversies that raged over it in its early days.

Such a view leads one to the conclusions that Heaviside was unquestionably a genius, that he and pure mathematicians simply did not approach compatibility, and that his unorthodox and sometimes intuitive methods led to striking results and probably goaded the pure mathematicians on in directions they might not otherwise have travelled, with the result that today Heaviside's procedures may be justified by processes of adequate mathematical rigor.

It then becomes a matter of preference as to whether the present-day workers stay with Heaviside's formalism, taking on all the risks of trying to follow a genius in his thought processes, or uses the more humdrum procedure on the Laplace transform and associated complex variable theory. The reviewer must confess a preference for the latter approach, and with it the possibility of bias.

The book is based on a series of out-of-hours lectures delivered to engineers of the Post Office Research Station. It begins with a review of the classical solution of the differential equations in terms of given boundary values. From there Heaviside's expansion method is introduced and applied to various cases. A theorem only recently discovered among Heaviside's papers is then demonstrated and used to obtain many further results. Apparently Heaviside himself did not use the theorem in this way.

The theorem itself is by now a well-known one, having been rediscovered at various times. What was not so well known was the fact that Heaviside had been thinking along such lines. The book closes with a chapter outlining the connections between the Heaviside operational approach and the modern mathematical procedures.

One minor objection that may be raised concerns the practice of writing the operational equation as an equation with an ordinary equality sign. Either a special symbol or a functional notation would seem to offer less possibility of confusion and would have ample precedent. Such criticism should not however be allowed to hide the fact that the book fulfills its avowed aim in a most commendable manner.

S. N. Van Voorhis
University of Rochester
Rochester, N. Y.

❖

Atomic Physics by Wolfgang Finkelnburg

Published (1950) by McGraw-Hill Book Co. 330 W. 42 St. New York 18, N. Y. 475 pages+17-page index+x pages. 226 figures. 9½×6½. $6.50.

This book attempts to present a connected account of the present state of our knowledge of the structure of matter from elementary particles up to the latest concepts of the solid state, at a level suitable for seniors and graduate students in science or engineering. The author has stressed the meaning of experiments and theories, and the interrelations between such seemingly divergent fields as atomic, molecular, nuclear and solid-state physics, without plunging the reader into a morass of mathematical or experimental details.

Following two chapters in which the groundwork for the discussion is developed with the introduction of the fundamental notions of atomic theory and of the elementary particles, Professor Finkelnburg gives an unusually readable account of the development of spectroscopy and the Bohr theory. In Chapter 4 he introduces quantum mechanics, pointing out just where the Bohr theory proved inadequate, and where the quantum theory scored its greatest successes. The final section of this chapter deals with the achievements, limitations and philosophical significance of quantum mechanics. The fifth chapter (98 pages) is devoted to nuclear physics, and the final two chapters are concerned with molecular physics and atomic physics of the liquid and solid state.

Each chapter is provided with an extensive bibliography, but specific references to original papers and mathematical derivations are generally lacking. While these omissions would seriously impair the value of the book as a text or reference work, they do make it more readable. In the opinion of this reviewer the book should be an excellent one for an engineer or scientist who wishes to bring himself up to date on the whole subject of modern physical thinking. In this respect I believe it fills a long-felt want.

The book appears to be unusually free of errors or misprints and only occasionally was I conscious of the fact that it is a translation from the German. The author has taken great pains to bring his material up to the minute and should be congratulated on a splendid job.

J. B. Horner Kuper
Brookhaven National Laboratory
Upton, L. I., N. Y.

❖

Primary Batteries by George Wood Vinal

Published (1950) by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 329 pages+6-page index+xi pages. 101 figures. 5½×8½. $5.00.

This is a new book, on a subject which has for long been in need of comprehensive treatment such as is incorporated in the twelve extended chapters of this work. In our recollection it is the only thorough treatment of primary batteries in many years covering history, theory, materials, chemical reactions, manufacture and operating char-

acteristics of standard cells, copper and copper oxide cells, silver oxide and chloride batteries, lead cells having soluble reaction products, mercury oxide and vanadium dry cells, and fuzed-electrolyte cells.

There are authoritative chapters on the operating characteristics of dry cells, and the effect of low temperature on dry cells and low-temperature types. Some primary batteries have been developed that are capable of discharge at high rates comparable with or surpassing those of storage batteries. Increased capacity in relation to weight and size has become possible with the development of new types. The temperature range through which they can operate has been extended in an effort to meet atmospheric conditions of the tropics and the artic.

A main value of the text is in the description of new and unfamiliar types of primary batteries, and in modern explanation of the actions of older types made possible by the availability of the electron microscope, X-ray spectrograph, and the mass spectrograph for the purposes of research.

A battery is described for radio sonde uses which has two sections for A and B circuits of a small radio transmitter which is elevated into the upper atmosphere to report meteorological conditions, the A section of two cells having a voltage of 3.6, the B section of forty-nine cylindrical cells in honeycomb formation having a voltage of ninety. Recent primary battery developments include the powerful silver oxide and chloride cells capable of discharge at high rates and having a flat voltage characteristic.

There is a nostalgic note in the reference to copper sulphate, or bluestone batteries. It appears they began to disappear from telegraph and telephone offices and railroad signal service about thirty years ago when the cost of copper sulphate sky-rocketed. There are graying telegraph and telephone engineers who in pensive moments live over again the over-time (gratis) night hours they put in scraping crow-foot zinc electrodes and punching encumbrances away from overburdened copper elements.

DONALD MCNICOL
Consulting Communication Engineer
25 Beaver St.
New York, N. Y.

❖

The Principles of Television Reception by A. W. Keen

Published (1949) by Sir Isaac Pitman and Sons, Ltd., London. 304 pages+5-page index+10-page appendix+xv pages. 235 figures. 5¾×9. 30/-.

This book was originally written for the engineers of a receiver manufacturer's servicing organization. It was designed to teach them the basic principles of television reception, including developments in color television, in a qualitative and theoretical fashion, i.e., without becoming involved in numerical and design details. It can also be recommended as a text for the general technical reader. Particular care has been taken to avoid mathematical complication, and the fundamental derivations have been placed in the appendix.

The electrical circuit material is well presented, and a background chapter on basic signal and circuit theory prepares one for the later discussions. There is also a background chapter on receiver testing, which is hardly enough instruction for a service man, but gives a good outline of the general principles in this aspect of the art. Another background chapter outlines the complete television process from the original scene on, and presents major British and American broadcast standards. The treatment becomes more sketchy when it comes to discussion of the visual performance of the receiver.

The book covers much of American as well as British practice in receiver design. The major difference between the two problems, namely, the number of simultaneous channels in use, and the consequent importance of image frequency response and local oscillator radiation in the American receiver, are covered rather briefly for the American reader.

In contrast with the general trend of the book to start from basic principles, the chapter on antenna theory and the discussion of colorimetry assume a higher degree of sophistication on the part of the reader. It is of course a severe task to compress a basic treatment of colorimetry into five pages, but the naïve reader, if he also sees other material on this subject, will be puzzled by the scaling of the three chromaticity diagram coordinates into equal units of brightness.

It is indicative of the rapid recent development in color television (characterized with apparent British understatement as "on a limited scale") that though the book was concluded in 1947, the descriptions of the color systems are now fairly well out-of-date.

PIERRE MERTZ
Bell Telephone Laboratories
463 West St.
New York 14, N. Y.

❖

Patent Practice and Management for Inventors and Executives by Robert Calvert

Published (1950) by Scarsdale Press, Box 536, Scarsdale, N. Y. 331 pages+15-page index+xi pages+14-page appendix. 6×9¼. $5.00.

Written by Robert Calvert, Ph.D., variously chemist, college professor, industrial research director, and patent attorney, the book has been prepared for inventors and executives, as its title implies. It is useful also for engineers engaged in industry. It includes information on applications, patents, their processing, and their handling to a degree desirable for executives, supervising engineers, and independent inventors, and to a lesser degree to others employed in industry. The various subjects are covered in as great detail as the intended readers are likely to be able to absorb, but not in the full and thorough fashion of books written for a patent attorney.

For the executive, there are chapters on license of patents, misuse of patents, utilization of patents without license, sale, or suit, measure of liability for infringement, tax law involved in patents, and foreign patents, their advantages and disadvantages.

For the engineering supervisor there are chapters covering the phases of patent procurement necessary to understand how engineers can best co-operate in the patent aspects of their work to secure protection of their technical advances.

For the average engineer, besides the patent information, items of special interest occur in chapters on who is the inventor, special incentives for inventors and executives, and patent rights of employers and employees.

For the independent inventor, who is his own business executive as well as design and research engineer, most of the book is pertinent to his interests.

The book will not suffice to dispense with a patent attorney. It will, however, answer many questions that come to mind when the patent attorney is not available, and supply valuable information that a patent attorney will not think of imparting unless asked.

The book is well written and easily readable. It contains a glossary of patent terms, an appendix of license and other forms, as well as an index of cases and authorities including authors, and a subject index that appears ample.

R. A. HEISING
Bell Telephone Laboratories
Murray Hill, N. J.

❖

The Radio Manual by George E. Sterling and Robert B. Monroe

Published (1950) by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y. 879 pages+v pages+11-page index. 821 figures. 8×10. $12.00.

This revised edition although still primarily an operating manual has a wealth of background theory and fundamental data. The book is specifically directed at the commercial radio operator. It contains complete and specific operating and maintenance instructions on present day Marine, Emergency, AM & FM Broadcast and Television transmitters. Marine receivers and Lifeboat Equipment are thoroughly covered. The new chapter on Emergency Service Radio Equipment (Police, Fire, etc.) covers the complete systems including antennaes and operating procedures. The chapter on Marine Navigational Aids has been revised to include Radar and Loran, as well as ordinary direction find equipment. Chapters are also provided on Radio Frequency Measurements and Broadcast Studio and Control Room Equipment. Backing up the foregoing chapters on actual equipment are well written chapters on elementary electrical and radio theory. These cover electricity and magnetism, motors and generators, batteries, electron tubes, amplifiers and oscillators, amplitude and frequency modulation, radio wave propagation and antennas. The three final chapters cover the state, federal and international conventions and laws of radio. Particular attention is merited by the excellent chapter on television prepared by Dr. T. T. Goldsmith. In 72 pages he covers the general theory and complete details of the overall system including test equipment and operating procedure. The arrangement of the chapters in conjunction with a complete index facilitates the location of material. The book is clearly printed and the illustrations are excellent. It forms a valuable reference volume for any engineering library and is particularly recommended for students and commercial operators.

JOHN D. REID
American Radio and Television Inc.
North Little Rock, Ark.

High Speed Computing Devices by Staff of Engineering Research Associates, Inc.

Published (1950) by McGraw Hill Book Co., 330 W. 42 St., New York 18, N. Y. 440 pages+11-page index+xiii pages+60 figures. 9¼×6¼. $6.50.

This volume, which represents the combined efforts of a number of members of the staff of Engineering Research Associates, Inc., is a very welcome one, for it is the most up-to-date book on the subject of machine computation and contains a wealth of information not readily available elsewhere. According to the foreword, the book is based on a report submitted to the Office of Naval Research in fulfillment of a contract which called for "an investigation and report on the status of development of computing machine components." Reflecting this fact, the book presents essentially the results of a broad survey of the field of machine computation, with emphasis on high-speed computing devices.

The book is divided into three parts of about equal length. Part 1 begins with a general discussion of various types of computing machines. Following this are given descriptions of some of the basic computing elements such as flip-flop counters, switching and gating circuits, converters, buffers, and adders. The material covered in the next three chapters is of an altogether different nature. Chapter 5 is given over to a discussion of programming of computational processes and the organization of standards commands for the general-purpose machine. Chapter 6 presents a discussion of several counting systems: binary, decimal, biquinary, etc., and outlines the basic arithmetic operations in these systems. Chapter 7 is concerned with the basic techniques of numerical analysis. One finds here a very good treatment of various interpolation formulas, methods of numerical integration and the principal methods of solution of ordinary differential equations.

Part 2 is devoted to a discussion of various types of computing systems. Included here are descriptions of desk calculators, punched-card computers, and large-scale digital computing systems. In particular, the ENIC and the UNIVAC, Mark I and II Calculators, the IBM Selective Sequence Calculator, Bell Telephone Laboratories' Relay Computers, and ERA Computer are described in some detail. Analog computers are treated briefly in Chapter 11, and only a few pages are devoted to electronic differential analyzers.

The last part of the book contains much useful information about the basic arithmetic components: adders, subtractors, accumulators, and multipliers. The usual storage devices- delay lines, magnetic tape, punched tape, and cathode-ray storage tubes are treated in varying degrees of detail. The last chapters of the book are devoted in the main to a description of data conversion devices, from digital to analog, and vice versa, and to discussion of other auxiliary techniques and equipment.

The book has many valuable features, as well as some weaknesses. A particularly noteworthy feature is the unusually complete and up-to-date bibliography which is appended at the end of each chapter. Perhaps the most noticeable weakness is the lack of continuity in the treatment of various topics and unevenness in emphasis.

On the whole, the book constitutes a valuable addition to the literature of machine computation and is a "must" for all those who are concerned directly or indirectly with the theory and practice of computing devices.

L. A. Zadeh
Columbia University
New York, N. Y.

❖

Electromagnetic Theory by Oliver Heaviside

Published (1950) by Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. 386 pages+xxx pages. 9×12. $7.50.

This work constitutes one of the most readable classics of modern applied science, in one volume, unabridged. It was published originally in three volumes between 1891 and 1912. Heaviside intended to write a fourth volume, but circumstances intervened, and in publishing volume 3, in 1912, he incorporated material intended for volume 4.

This work incorporates treatment of more than 500 topics, including Maxwell's theory, eolotropic relations, electric stress in air, depth of the electrified layer on conductors, waves from moving sources, waves in the ether, sound waves, Lagrange's equations, etc. Heaviside was the first to investigate mathematically the problem of the coaxial cable. The consolidated work may be regarded as a summary of Heaviside's matured views on these subjects, concluded by challenging paragraphs on "Limitations on Scientific Prediction." The extended Introduction by Professor Ernst Weber is a critical and historical review of Heaviside's life and works.

In his published Notes of 1885–1886, Heaviside discussed the use of the terms resistivity, permeability, capacity, etc., and he expressed alarm as to "the frightful names that might have been given the electrical units by the Germans." The salty and incisive language of Heaviside's writings is refreshing and inspirational. He enjoyed tilting with the Cambridge mathematicians because of their "distressing and soul-destroying style in doing their work." Actually, Heaviside's unorthodox methods were so sketchily explained as to shock the conservative rigorists of the time. Heaviside's writings disclose that he had unbounded admiration for Maxwell's Theory unifying the known facts of electrostatics, electrokinetics, and electromagnetics—at the time of Maxwell's death in 1879, still speculative because no experimental evidence of wave propagation had been given. Thenceforth Heaviside asserted himself as a vigorous disciple of Maxwell.

Heaviside, like Edison and a host of other men who achieved renown, in his youth became a telegraph operator and took advantage of opportunities incidental to such employment to study and experiment.

The publication of this work places Heaviside's writings within reach of all colleges and technical schools, as well as of earnest students who realize the direct value of personal libraries.

Donald McNicol
Communication Engineer
25 Beaver St.
New York, N. Y.

Wave Filters by L. C. Jackson

Published (1950) by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 103 pages+2-page index+vii pages. 64 figures. 4½×6¼. $1.25.

This book is a third edition of one of the handy pocket sized Methuen's monographs on physical subjects and was first published in 1944.

The author's intention is to strike a happy medium between standard treatises on wave filters, and the brief treatments given in texts on general communication engineering. Unfortunately, the result is a rather uninspired collection of formulas for conventional filter types, with slightly more explanation than is found in the usual handbook treatment. No mention is made, either in the text or bibliography, of the modern filter design methods of Guillemin, Bode, Ralington, and others.

Other filter types are discussed briefly, including coupled circuits, quartz crystals, coaxial lines, and mechanical and acoustic applications.

C. W. Carnahan
Sandia Corporation
Albuquerque, N. M.

❖

Circuits in Electrical Engineering by Charles R. Vail

Published (1950) by Prentice-Hall, Inc., 70 Fifth Avenue, N. Y. 497 pages+12-page index+xv pages. 206 figures. 6×8¼. $7.65.

This book was written to cover the "demands . . . made of electric circuits courses by the typical modern electrical engineering curriculum." "An introductory course in electrical engineering is not absolutely essential to successful use of the book, A knowledge of mathematics through basic calculus is assumed." Whether the book is intended for the circuits courses of the whole curriculum or for only the first introductory course is not stated. This is important, since repetitive networks such as filters and transmission lines are not mentioned, although an introduction to transient theory is included.

The book evokes a curious combination of reactions from this reviewer. From many angles it is just another elementary textbook. The tedious detail of many of the analyses (such as reactive power) would seem unnecessary for students of average ability. In fact, the student might well profit by doing the detailed development of such relationships for himself. The problems are humdrum and routine, so that no play of imagination is invited.

Yet there are certain excellent features about the book. The drill is thorough, so that the student should certainly grasp the mechanics of the techniques discussed. The concept of the principle of duality in circuit theory is well discussed. And the balanced discussion of complicated networks from the loop and node points of view should prove extremely useful to the student in his later work. All of the treatment is given for the general case of any frequency including direct current.

In short, the point of view is excellent, the treatment pedestrian.

Knox McIlwain
Hazeltine Electronics Corp.
Little Neck, L. I., N. Y.

Abstracts and References

Prepared by the National Physical Laboratory, Teddington, England, Published by Arrangement with the Department of Scientific and Industrial Research, England, and *Wireless Engineer*, London, England

NOTE: The Institute of Radio Engineers does not have available copies of the publications mentioned in these pages, nor does it have reprints of the articles abstracted. Correspondence regarding these articles and requests for their procurement should be addressed to the individual publications, and not to the IRE.

Acoustics and Audio Frequencies..... 1468
Antennas and Transmission Lines..... 1469
Circuits and Circuit Elements..... 1470
General Physics..... 1472
Geophysical and Extraterrestrial Phenomena..... 1472
Location and Aids to Navigation..... 1473
Materials and Subsidiary Techniques.. 1473
Mathematics..... 1474
Measurements and Test Gear..... 1475
Other Applications of Radio and Electronics..... 1476
Propagation of Waves..... 1477
Reception..... 1477
Stations and Communication Systems.. 1478
Subsidiary Apparatus..... 1478
Television and Phototelegraphy..... 1478
Transmission..... 1479
Tubes and Thermionics..... 1479
Miscellaneous..... 1480

The number in heavy type at the upper left of each Abstract is its Universal Decimal Classification number and is not to be confused with the Decimal Classification used by the United States National Bureau of Standards. The number in heavy type at the top right is the serial number of the Abstract. DC numbers marked with a dagger (†) must be regarded as provisional.

The Annual Index to these Abstracts and References, covering those published in the Proc. I.R.E. from February, 1949, through January, 1950, may be obtained for 2s. 8d. postage included from the *Wireless Engineer*, Dorset House, Stamford St., London S. E., England. This index includes a list of the journals abstracted together with the addresses of their publishers.

ACOUSTICS AND AUDIO FREQUENCIES

016:534 2682

References to Contemporary Papers on Acoustics—A. Taber Jones. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 522–528; July, 1950.) Continuation of 2395.

534.231 2683

The Propagation of a Sound Pulse in the Presence of a Semi-Infinite Open-Ended Channel: Part 1—W. Chester. (*Phil. Trans. A*, vol. 242, pp. 527–556; September 5, 1950.) Two problems are discussed. In the first, a sound pulse originates inside a duct between two semi-infinite parallel planes and travels to and beyond the open end, where it undergoes partial reflection. In the second case, the pulse originates outside the duct and approaches the open end from an arbitrary direction. A succession of diffracted waves is created at the end of the duct, for which in the first case a general formula is derived by operational methods. A simple reciprocity relation is applied to deduce the form of the wave in the duct in the second case. Ultimately the returning wave becomes sensibly plane and splits up into regions of length equal to the distance between the boundary planes, the form of the potential depending on the number of diffracted waves which contribute to each particular region. Explicit expressions are obtained for the potential in the first two regions at the head of the returning wave and for the third region when the pulse originates within the duct. The case of an initial velocity distribution given by the Heaviside unit pulse is treated in detail.

534.232:534.321.9 2684

The Relative Output from Magnetostriction Ultrasonic Generators—F. M. Leslie. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 418–421; July, 1950.) Equivalent transmission-line circuits are used to develop formulas for the resonance frequency and output of the simple bar oscillator and the dumbbell type. Approximations in the latter case do not introduce any great discrepancy between calculated and measured values of resonance frequency. The formulas, though applicable directly to the symmetrical dumbbell oscillator, may be easily applied to the asymmetrical oscillator and to those in which the face area is less than the cross-section of the neck.

534.232:534.321.9:621.3.087.6 2685

Application of Supersonic Energy to High Speed Electronic Recording—H. J. Dana and J. L. Van Meter. (*Proc. NEC* (Chicago), vol. 5, pp. 473–476; 1949.) See 1561 of August.

534.24:532.582.3 2686

Sound Scattering from a Fluid Sphere—V. C. Anderson. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 426–431; July, 1950.) A mathematical solution is obtained for scattering from a sphere of size comparable with the wavelength, with acoustic properties near to those of the surrounding medium. The reflectivity for direct backward scattering is presented as a function of relative density and relative sound velocity. Comparison is made with the Rayleigh limiting case and with the case of a fixed rigid sphere. For diameters comparable with the wavelength, scattering may show pronounced maxima and minima.

534.373:534.213.4 2687

Classical Viscosity in Tubes and Cavities of Large Dimensions—B. P. Bogert. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 432–437; July, 1950.) "A method for the calculation of viscous losses in acoustic wave guides and cavities is described, similar to that used by Carson, Mead, and Schelkunoff for electromagnetic waves. The loss in a plane wave in a round tube is discussed and the results agree with those previously obtained by others. The attenuation for two higher modes in hard-wall guides is computed, as well as the decay constants for a cylindrical cavity for longitudinal and pure radial modes."

534.414 2688

Acoustic Resonators of Circular Cross-Section and with Axial Symmetry—A. K. Nielsen. (*Trans. Dan. Acad. Tech. Sci.*, no. 10, 70 pp; 1949. In English.) The literature on this subject is critically reviewed. The usual approach to resonator theory is inadequate for two reasons. Firstly, the velocity distribution in the coupling aperture is usually assumed constant in order to satisfy boundary conditions. This assumption actually violates the boundary condition at the sharp edges of the coupling aperture, where the velocity becomes infinite (neglecting losses). Secondly, the interaction between the wave emitted from the coupling aperture and that reflected from the cylindrical walls of the resonator has been neglected. An expression for the velocity distribution is derived which satisfies the rise-to-infinity condition at the edge of the aperture and a formal solution of the wave equation is obtained, assuming the velocity distribution in the aperture to be known. The results are used to calculate the resonance frequency of a symmetrical resonator by the energy method. Formulas are also given for asymmetrical resonators. The end correction for a flanged organ pipe is found to be $0.8220r$, a slightly better approximation than Rayleigh's value of $0.8242r$. The effects of viscosity and heat conduction are also considered. Experimental results for various resonators and flanged organ pipes agreed with the theoretical values to within 1 per cent.

534.417:621.395.614† 2689

Crystal Microphone for Underwater Sounds—W. Guttner. (*Z. Angew. Phys.*, vol. 2, pp. 206–210; May, 1950.) The microphone consists of 10 Rochelle-salt plates with 45° X-cut mounted between elastic supports so that the sound pressure acts only on the front membrane. Its response characteristic is shown; this is largely independent of temperature change. The method of calibration is described The measured response of the receiver agrees well with values calculated from crystal data.

534.442 2690

Methods and Instruments for the Visual Analysis of Complex Audio Waveforms—H. R. Foster and E. E. Crump. (*Proc. NEC* (Chicago), vol. 5, pp. 564–572; 1949.)

534.442.2:621.392.52 2691

A Continuously Variable Filter—C. G. M. Fant. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 449–453; July, 1950.) A heterodyne filter for the speech frequency range is described. Bandpass filtering with continuously variable low- and high-frequency cutoffs or band-elimination filtering with variable mid-frequency and fixed bandwidth are possible. Variable filtering is performed by ssb transmission with successive filtering and demodulation. The filter was designed for speech investigations and wave analysis in the range 40–2,000 cps.

534.75:534.792 2692

The Frequency Selectivity of the Ear as Determined by Masking Experiments—T. H. Schafer, R. S. Gales, C. A. Shewmaker, and P. O. Thompson. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 490–496; July, 1950.)

534.78:621.314.26 2693

Devices for Speech Analysis and Compression—F. Vilbig. (*Proc. NEC* (Chicago), vol. 5, pp. 573–581; 1949.)

534.833.4 2694
Acoustic Materials—(*Tech. Bull. Nat. Bur. Stand.*, vol. 34, pp. 96–102; July, 1950.) A review of the essential theory of sound absorption, the principles governing the use of absorptive materials, the various types of such materials, their physical properties and methods of measurement.

534.846.6 2695
The Use of Three-Dimensional Models in Room Acoustics—R. W. Muncey. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 510–511; July, 1950.) The chief difficulty in the construction and use of models for investigation of room acoustics is the provision of bounding surfaces to simulate the properties of those of the full-size hall. Investigations of the use of small-scale models has been commenced in the Building Research Laboratory, Victoria, Australia.

621.3.018.78:621.317.79† 2696
An Intermodulation Analyzer for Audio Systems—Fine. (*See* 2840.)

621.395.612.45 2697
New "Unobtrusive" Ribbon Pressure Microphone—H. F. Olson and J. Preston. (*Broadcast News*, pp. 24–28; May and June, 1950. *Audio Eng.*, vol. 34, pp. 18–20; July, 1950.) Theory and description of a microphone with uniform response from 50 cps to 15 kc. A small pickup horn applies sound pressure to the ribbon through a cylindrical tube and tapered connector, the back of the ribbon being coupled to the damping labyrinth by a similar connector.

621.395.623.7 2698
Electroacoustic Phase Shift in Loudspeakers—C. A. Ewaskio and O. K. Mawardi. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 444–448; July, 1950.) The modulation phase-shift method of Nyquist and Brand was adapted for direct indication of envelope delay (the slope of the phase-shift curve) by using an electronic phase-meter. A continuous record was obtained of the delay for various loudspeakers by means of an automatic level recorder suitably connected to the phase-meter. The results, together with pressure-amplitude response curves, may serve as a basis for assessing the quality of a loudspeaker.

621.395.625.3:681.6 2699
Duplication of Magnetic Tape Recordings by Contact Printing—Herr. (*See* 2804.)

621.395.625.3:681.6 2700
A New Magnetic Record Duplicating Process—Camras. (*See* 2803.)

681.85 2701
A Variable Speed Turntable and its Use in the Calibration of Disk Reproducing Pickups—H. E. Haynes and H. E. Roys. (*Proc. NEC* (Chicago), vol. 5, pp. 556–563; 1949.) See 1578 of August.

681.85:534.862.4 2702
The Diamond as a Phonograph Stylus Material—E. J. Marcus and M. V. Marcus. (*Audio Eng.*, vol. 34, pp. 25–27, 41; July, 1950.) The properties of natural diamonds, which make them pre-eminent for use as stylus points, are described, and a photographic comparison is made of the normal wear of commonly used stylus materials, showing the very great superiority of the diamond. Natural small stones, owing to their greater structural strength, are better than chips cut from larger gem stones. A short account is given of the occurrence of the stones and of the methods of preparing them for use.

534.321.9:[5+6 2703
Der Ultraschall und seine Anwendung in Wissenschaft und Technik (Ultrasonics and its Application in Science and Technology) [Book Review]—L. Bergmann. Publishers: S. Hirzel Verlag, Zürich, 5th edn 1949, 748 pp., 50 Swiss fr. (*Jour. Acous. Soc. Amer.*, vol. 22, p. 517; July, 1950.) "The author has rendered a genuine service to all workers in ultrasonics and allied fields by bringing together so much valuable material in one place and organizing it so systematically and efficiently. No worker in the field can really afford to have this book very far away from his desk." Over 2,300 references are included. The 3rd edition was noted in 280 of 1946.

534.833.4 2704
Sound-Absorbing Materials [Book Review]—C. Zwikker and C. W. Kosten. Publishers: Elsevier Publishing Co., 1949, Amsterdam, Brussels, and New York; Cleaver-Hume Press, London, 1949, 174 pp., $3.00 (*Research* (London), vol. 3, pp. 281–282; June, 1950.) "A highly scientific study of the physical behavior of sound waves impinging on and penetrating into absorbent constructions of any type."

534.84 2705
Acoustical Designing in Architecture [Book Review]—V. O. Knudsen and C. M. Harris. Publishers: J. Wiley and Sons, New York, 1950, 404 pp., $7.50. (Proc. I. R. E., vol. 38, p. 832; July, 1950.) A nonmathematical presentation. A little space is devoted to discussion of sound-amplification systems and studio design. Tables of sound-absorption coefficients and sound-insulation data are brought together in the appendices.

ANTENNAS AND TRANSMISSION LINES

621.392.26† 2706
Some Properties of Waveguides with Periodic Structure—A. W. Lines, G. R. Nicoll, and A. M. Woodward. (*Proc. IEE* (London), Part III, vol. 97, pp. 263–276; July, 1950.) A general description of the frequency characteristics of waveguides with periodic structure is derived from a discussion of loaded transmission lines. Analysis of an equivalent circuit is used to give a detailed confirmation of these characteristics. The periodic guide with systematically detuned resonators is then examined by these methods, all the general features being obtained by elementary reasoning. A more detailed treatment, based on Maxwell's equations, is required for specific design problems and this is employed in the design of a periodic waveguide with every third resonator detuned, for which a space harmonic exists with constant phase velocity over a wide frequency band. Possible experimental techniques for checking the theoretical frequency characteristics are discussed and the results obtained by one technique for the constant-phase-velocity guide are given.

621.392.26†:621.3.09 2707
Electromagnetic Waves in Circular Wave Guides Containing Two Coaxial Media—R. D. Teasdale and H. J. Higgins. (*Proc. NEC* (Chicago), vol. 5, pp. 427–441; 1949.) The general problem is treated in detail. A conditional equation governing propagation in such waveguides is derived. The two conditions for which simple E or H waves can be propagated are determined and discussed. Curves relating phase velocity to design parameters are plotted for the E_0 wave and examples are discussed for which the general solution reduces to particular solutions given by other authors.

621.392.26†:621.3.09 2708
On the Theory of Electromagnetic Radiation in Metal Tubes—R. Honerjager. (*Zeit. für Phys.*, vol. 128, pp. 72–78; June 20, 1950.) The radiation field of an electric and magnetic dipole of given moment in an infinitely long straight metal tube of arbitrary cross-section is calculated for E and H waves, and also the total em power flux through the tube.

621.396.67+621.396.611.1 2709
A Combination Slot Antenna and Resonant Tank Circuit—N. L. Harvey. (*Proc. NEC* (Chicago), vol. 5, pp. 183–189; 1949.) An impedance transforming and coupling network is usually required between the transmitter unit and the antenna. The coupling network can be eliminated by using the edges of the antenna slot as the resonant circuit of the transmitter unit. Such an arrangement is especially suitable for wide-band applications.

621.396.67 2710
Impedance and Radiation Characteristics of Slotted-Cylinder Antennas—R. E. Beam and H. D. Ross, Jr. (*Proc. NEC* (Chicago), vol. 5, pp. 172–182; 1949.) Approximate theoretical expressions are developed for the input impedance and radiation patterns of a slotted-cylinder antenna with a narrow slot of length equal to or greater than the free-space half wavelength, and fed at the midpoint of the slot. The antenna is considered as a slot-loaded cylindrical waveguide in calculating the cut-off frequency and phase constant along the slot. Babinet's principle is applied to the determination of the radiation resistance. Experimental results are in good agreement with theory.

621.396.67 2711
Slot Radiators—N. A. Begovich. (Proc. I.R.E., vol. 38, pp. 803–806; July, 1950.) By an extension of Babinet's principle Booker has shown (1335 of 1947) that the field pattern of a slot antenna is identical with that of the corresponding wire antenna, but with the electric and magnetic fields interchanged. A rigorous proof of this is now given, using the double-current-sheet diffraction formula. Integration of Poynting's vector over both surfaces of the slot gives a driving impedance of $362.5+j210.5$. The real part of this is in excellent agreement with experimental measurements. The mutual impedance between slots, necessary for array calculations, is also determined.

621.396 2712
The Slot Radiator, a Magnetic Dipole for Centimetre Waves—H. Severin. (*Zeit. für Phys.*, vol. 128, pp. 108–119; June 20, 1950.) The slot radiator is represented as a magnetic dipole and its mode of operation by the theory of diffraction of em waves at a small aperture in a perfectly conducting screen. Measured values of the radiation from and magnetic moment of small elliptical-slot radiators disposed respectively parallel and perpendicular to the magnetic field of the incident wave are in good agreement with calculations, provided the linear dimensions of the apertures are $<\lambda/3$.

621.396.67 2713
Correction of Spherical Aberration by a Phased Line Source—R. C. Spencer, C. J. Sletten, and J. E. Walsh. (*Proc. NEC* (Chicago), vol. 5, pp. 320–333; 1949.) Theory of the spherical reflector with corrected line source is developed. Tests using feeds such as open waveguides, horns, polyrod, slotted and dipole line sources show that if the phasing is suitably adjusted, aberrationless scanning of a pencil beam over at least $\pm 30°$ in any direction can be achieved.

621.396.67 2714
The Electromagnetic Field in the Vicinity of a Linear Conductor—P. H. Nelson. (*Proc. NEC* (Chicago), vol. 5, pp. 315–319; 1949.) A study is made of the interference pattern in

the vicinity of a linear conductor, of infinite length and zero resistance, subjected to the action of a plane em wave with electric-field vector parallel to the conductor. The reradiated field is independent of the incident field except at the surface of the conductor, so that superposition of the incident and radiated fields gives the interference pattern required. Experiments at a frequency of 3,000 Mc with some simple types of conductor gave results in close agreement with theoretical calculations.

621.396.67 2715

End-Loaded and Expanding Helices as Broad-Band Circularly Polarized Radiators—P. W. Springer. (*Proc. NEC* (Chicago), vol. 5, pp. 161–171; 1949.) The simplicity of the axial-mode helix makes it particularly suitable for the radiation of circularly polarized waves, but for applications requiring either modified radiation patterns or broad transmission bands it is often necessary to modify the simple helix. Two types, the short end-loaded helix and the expanding helix, are of particular value where extreme bandwidths are required. The theory of operation, impedance curves, polar diagrams, current and phase distribution are discussed and arrays are described providing (*a*) broad azimuth coverage, (*b*) sharp radiation patterns.

621.396.67 2716

Antifading Broadcast Antenna—H. Brueckmann. (*Electronics*, vol. 23, p. 228; August, 1950.) Correction to article abstract in 1863 of September.

621.396.67:621.317.79 2717

The Electronically Driven Ripple-Tank as an Aid to Phase-Front Visualization—Schooley. (*See* 2841.)

621.396.67:621.392.26† 2718

The Channel-Guide Antenna—W. Rotman. (*Proc. NEC* (Chicago), vol. 5, pp. 190–202; 1949.) The general condition for radiation from the slot of a channel-guide antenna is derived in terms of the near-field distribution of em energy, which may be described as a form of single-mode transmission in the supporting waveguide, characterized by a complex propagation constant. A method of computing the propagation constant gives results for different channel geometries which are in agreement with experiment. Practical methods of coupling channel-guide antennas to microwave sources are considered.

621.396.67:621.397.62 2719

An Automatic Built-In Antenna for Television Receivers—K. Schlesinger. (*Proc. NEC* (Chicago), vol. 5, pp. 292–302; 1949.) See 819 of May.

621.396.67.012 2720

A Graphical Analysis of the Interference Patterns of an Elevated Ultra-High-Frequency Antenna under Conditions of Atmospheric Stratification—F. R. Abbot and C. J. Fisher. (*Jour. Appl. Phys.*, vol. 21, pp. 636–641; July, 1950.)

621.396.67.029.64:535.42 2721

Small-Surface Microwave Diffraction—A. Applebaum and P. C. Fritsch. (*Proc. NEC* (Chicago), vol. 5, pp. 442–449; 1949.) The diffraction of plane-polarized em waves by reflection from small perfectly conducting surfaces (diameter of the order of λ) is calculated for any angle of incidence by Schelkunoff's "current-sheet" method. A correction for boundary effects is determined. Experimental results obtained with an unmodulated reflex klystron, Type 2K39, as the power source, are in good agreement with theory.

621.396.673:621.397.61 2722

1057-Foot FM-TV Antenna—(*Broadcast News*, no. 59, pp. 8–15; May and June, 1950.) Situated at Atlanta, Ga., a 1,000-ft tower supports an RCA Supergain television antenna (1865 of September). Above this is a FM antenna, a 4-section pylon, RCA Type BF-14D. The television antenna has a gain of 11.5, which, with a 5-kw transmitter, gives an effective radiated power of 52 kw. The FM antenna has a power gain of 6; provision is made for an additional four sections to double this gain. The earthing system consists of radial copper straps 50 ft. long spaced every five degrees, buried 6 in. deep and terminating in copper earthing rods.

621.396.677 2723

A Wide-Angle Microwave Radiator—S. S. D. Jones. (*Proc. IEE* (London), Part III, vol. 97, pp. 255–258; July, 1950.) If a glass sphere of unit radius could be produced with a refractive index $\mu=\sqrt{(2-r^2)}$ where r is the radial distance from the centre, the sphere would act as a lens with a focus on the surface of the sphere. A microwave analogue has been constructed using spaced conducting sheets. The lens is free from aberrations as the feed is moved around the circumference and is therefore suitable for wide-angle scanning. The measured performance agrees well with theory.

621.396.677:538.31:538.214 2724

The Effective Permeability of an Array of Thin Conducting Disks—Estrin. (*See* 2765.)

621.396.677.2 2725

Theoretical Investigations on the Radiation Impedance of Transmitting Aerials—J. Patry. (*Schweiz. Arch. Angew. Wiss. Tech.*, vol. 16, pp. 138–147; May, 1950.) The theory of Hallen is extended to antenna arrays, in particular to symmetrical dipole arrays for metre waves. The two special problems considered are the interaction of parallel dipoles with parallel feed and the effect of the spacing between the two elements of a dipole. The complex general formula is simplified for the resonance case treated here. The values of expressions from which the radiation resistance can be found are given in a table referring to 12 different arrays of similar dipoles.

CIRCUITS AND CIRCUIT ELEMENTS

621.314.2.018.424.029.3 2726

Audio-Frequency Transformer with Range Extended Below One Cycle Per Second—D. W. Kuester. (*Proc. NEC* (Chicago), vol. 5, pp. 255–257; 1949.) Discussion of design problems and description of a transformer for connection between a 72-Ω line and a 10-kΩ grid circuit, with a flat response curve from 0.2 cps to 20 kc.

621.314.263 2727

The Magnetic-Cross Valve and its Application to Subfrequency Power Generation—H. J. McCreary. (*Proc. NEC* (Chicago), vol. 5, pp. 450–466; 1949.) Basic theory and characteristics are discussed, showing how subharmonics may be obtained by a process of magnetic energy transference without moving parts or mutual inductance. Results of experimental analysis are used to show how a single flux vector may vary cyclically, but with different periods along two axes, resulting in the production of sub-harmonics. Details are given of the performance of a "Power Ringer" employing the device; this converts 60 cps power to 20 cps and has been in use in a telephone exchange for 4 years without attention.

621.314.3† 2728

The Magnetic Amplifier—J. S. W. Graham. (*Strowger Jour.*, vol. 7, pp. 104–119; July, 1950.) Fundamental principles are outlined and power control, amplification ratio, continuously variable control, feedback, time lag core materials, and general design features are considered in detail. Application to rhythmic ("rhythmatic") ripple control is described, with test results.

621.314.3† 2729

The Problem of the Magnetic Amplifier and Some Approaches to Its Solution—M. Liwschitz-Garik, E. J. Smith, and E. Weber. (*Proc. NEC* (Chicago), vol. 5, pp. 235–254; 1949.) Various possible methods of steady-state analysis are considered and the question of the best representation of the magnetization characteristic of a core under conditions of asymmetrical magnetization is discussed. Experimental results are given illustrating the effect of dc bias on the ac magnetization curve. Results for half-wave and full-wave magnetic amplifiers are computed by a point-by-point procedure and by a method based on the representation of the magnetization curve by three linear elements. The latter method yields satisfactory results in much the shorter time.

621.314.3† 2730

An Extension of a Theory of Magnetic Amplifiers—R. T. Beyer and Ming-Yi Wei. (*Jour. Frank. Inst.*, vol. 250, pp. 25–37; July, 1950.) The theory previously given (2730 of 1949) is extended to the case of large dc inputs and the presence of harmonics in the primary current, the ac impedance of the secondary being assumed infinite. Experimental evidence supports the calculations, which show a nonlinear relation between dc input and second-harmonic output, the latter passing through a maximum as the ac is increased. The influence of a third-harmonic component in the primary current is also investigated; for small input currents it may be neglected without serious error.

621.314.3†:681.142 2731

Magnetic Amplifier Studies on the Analog Computer—E. L. Harder, W. H. Hamilton, D. F. Aldrich, J. T. Carleton, and F. N. McClure. (*Proc. NEC* (Chicago), vol. 5, pp. 222–234; 1949.) A description is given of an electrical analogue to magnetic circuits and its application to the study of such circuits. Methods of applying the analogue to specific design problems are discussed. The nonlinear characteristics of iron are reproduced by using a multiple-diode nonlinear-resistance circuit, whose characteristic simulates the true B/H curve by means of 20 successive linear elements.

621.316.842+621.316.86 2732

Wideband Power Resistors—H. L. Krauss and P. F. Ordung. (*Electronics*, vol. 23, pp. 186–194; August, 1950.) A 30-w carbon-film resistor 10 in. long and 1¼ in. in diameter provided a satisfactory reactance-free 500-Ω termination up to 50 Mc when mounted in free space, but not when near an earthed plane, owing to stray capacitance. A terminated wire-wound resistor with 8 turns/in. on a former 1 in. in diameter, with carbon resistors connecting it to the earthed plane at suitable intervals so as to satisfy the distortionless transmission-line equation $R/G=L/C$, gave very satisfactory results up to 50 Mc.

621.318.572 2733

Electronic Decade Counter with Direct Indication by means of Neon Lamps—A. Peuteman. (*Compt. Rend. Acad. Sci., Paris*, vol. 230, pp. 2160–2162; June 19, 1950.) See also 660 of 1949 (Naslin and Peuteman).

621.318.572:621.3.015.7 2734

A Pulse Length Sorter and Counter—R. J. Parent and R. W. Schumann. (*Proc. NEC* (Chicago), vol. 5, pp. 72–92; 1949.) Pulses of random length and spacing, which occur at a rate of up to 10^3 per minute, can be sorted according to duration into 15 ranges. Sorting

is achieved by biased circuits fed from a step-wave circuit driven by a multivibrator, which is gated by the random pulses to be measured. The number of pulses in each range is counted by binary scaling chains following each bias circuit. Circuits are described in detail, with the aid of diagrams and waveforms.

621.319.42 2735

The Influence of Operating Conditions on the Construction of Electrical Capacitors—A. E. Bennett and K. A. Gough. (*Proc. IEE* (London), Part III, vol. 97, pp. 231–241; July, 1950.)

621.392 2736

The Design of Wide-Band Phase-Splitting Networks—W. Saraga. (PROC. I.R.E., vol. 38, pp. 754–770; July, 1950.) A general investigation of phase-splitting networks, dealing with network analysis, network synthesis, and performance-curve approximation problems. Explicit formulas for any number of design parameters and for any required degree of approximation are stated for Taylor and Tchebycheff approximations. Clear design instructions for both simple and difficult network specifications are obtained. Novel methods are developed for obtaining dissipation compensation, for network synthesis, and for representing the approximating curves as iterated functions of two variables, with fractional index of iteration.

621.392.5 2737

Frequency Analysis of Variable Networks—L. A. Zadeh. (PROC. I.R.E., vol. 38, p. 725; July, 1950.) Corrections to paper abstracted in 1617 of August.

621.392.5:621.3.015.7† 2738

The Determination of the Impulsive Response of Variable Networks—L. A. Zadeh. (*Jour. Appl. Phys.*, vol. 21, pp. 642–645; July, 1950.) "Starting with the differential equation relating the output and the input of a linear varying-parameter network, it is shown that the impulsive response of the system is related to a Green's function associated with the system through a linear operator which is the adjoint of the right-hand operator in the given differential equation. A perturbation procedure [2835 of 1948 (Gray and Schelkunoff)] for the determination of the impulsive response of a slowly varying network is outlined. Use of the method is illustrated by a simple example involving a bandwidth-modulated RC half-section."

621.392.52 2739

Continuously Adjustable Electronic Filter Networks—G. E. Tisdale. (PROC. I.R.E., vol. 38, pp. 796–798; July, 1950.) The use of passive RC networks is discussed in terms of standard network theory. Frequency response is largely determined by these passive networks, while valves serve to isolate the various RC sections, to raise the output level, and to provide negative feedback. Design procedure is indicated and applied to adjustable low-pass and high-pass filters.

621.392.52 2740

A Crystal Filter of Variable Selectivity with Stable Resonance Frequency and Constant Gain—W. Kautter. (*Rev. Telegr.*, (Buenos Aires), vol. 37, pp. 137–142; March, 1949.) Basically, the filter consists of two intermediate-frequency amplifier units coupled by the crystal. The bandwidth is altered by detuning the two circuits in opposite directions: the resulting resonance shift is $<b_{max}/24$, where b_{max} is the maximum bandwidth, and thus falls within tolerable limits. The crystal dynamic resistance does not affect the operation of the filter, at least to a first approximation. The gain is constant and equal to that of a conventional intermediate-frequency stage over the whole band. Neutralization of the crystal dynamic capacitance, and the type of coupling required between crystal and circuits, are discussed. Crystals that are free from spurious responses near the working frequency are essential.

621.392.52:621.3.015.3 2741

Transient Response of Filters—M. S. Corrington. (*Proc. NEC* (Chicago), vol. 5, pp. 519–549; 1949.) Reprint. See 60 of February.

621.392.52:621.392.26† 2742

Low-Q Microwave Filters—J. Reed. (PROC. I.R.E., vol. 38, pp. 793–796; July, 1950.) An analysis of waveguide bandpass filters of the type previously investigated by Pritchard (1000 of 1948), Fano and Lawson (695 of 1948) and Mumford (1320 of 1949), in which each stage comprises two spaced inductive irises and successive stages are separated by $\lambda/4$ sections of optimum length $s+\lambda g/4$, where s is the iris spacing. Variation with frequency of the iris susceptance has a substantial effect on the loaded Q, especially for low values of Q. The theory was checked by experiments in which pairs of brass rods were substituted for irises

621.392.52:621.392.26† 2743

Design Relations for the Wide-Band Waveguide Filter—S. B. Cohn. (PROC. I.R.E., vol. 38, pp. 799–803; July, 1950.) Simplified formulas are derived and presented graphically for the design of nonuniform waveguide structures of the type previously considered (2469 of 1949). A numerical example is worked out. Measurements were made on specially constructed waveguide sections, and the calculated values of cut-off and infinite-attenuation frequency were found reliable to within 2 per cent.

621.392.52.029.4 2744

Continuously Adjustable Low- and High-Pass Filters for Audio Frequencies—A. Peterson. (*Proc. NEC* (Chicago), vol. 5, pp. 550–555; 1949.) Audio-frequency filter circuits are described in which the cut-off frequency is continuously variable over a 3:1 range with little change in the pass-band response. Each filter section uses two capacitors, a low-Q inductor, and a twin-triode reactance circuit with control by a single potentiometer. Beyond cut-off the attenuation is about 18 db per octave.

621.396.611.3 2745

An Analysis of Triple-Tuned Coupled Circuits—N. W. Mather. (PROC. I.R.E., vol. 38, pp. 813–822; July, 1950.) Circuits having high Q are considered, the couplings being loose and the response symmetrical about a reference frequency. Universal response curves are derived and contour plots for the product of gain and bandwidth are given. Compared with double-tuned circuits the triple-tuned circuit has the advantages of more uniform response inside the pass band, greater rejection outside it, and a larger value for the product of gain and bandwidth.

621.396.611.4 2746

Coupling between Two Degenerate Modes through Slots Cut in the Wall of a Cavity—Han C. Hu. (*Proc. NEC* (Chicago), vol. 5, pp. 467–472; 1949.) An analytical and graphical presentation of slot patterns is given. Experimental results obtained with a test cavity, and oscillograms showing transmission and absorption characteristics for TE_{112} and TE_{113} degeneracy, are used to indicate a way of achieving a precise degree of coupling.

621.396.615.14:621.385.029.63/.64 2747

The Helix as Resonator for Generating Ultra High Frequencies—van Iperen. (*See* 2944.)

621.396.645 2748

A 60-db Nonlinear Amplifier—J. A. Carruthers. *Canad. Jour. Res.*, vol. 28, pp. 287–292; May, 1950.) The amplifier described has been used to drive an Esterline Angus 0-1-mA recording galvanometer as part of the apparatus for automatically recording the radiation patterns of microwave antennas. By using automatic value control, the amplifier output is made approximately proportional to the logarithm of the input, thus enabling a 60-db variation of input signal to be plotted. The speed of response is limited by the galvanometer movement, but is adequate for obtaining a pattern through 100° of azimuth in about two minutes. Plotting is accurate to within 1 db if care is taken to check calibration frequently.

621.396.645 2749

Cathode-Follower Amplifiers—F. Navascues. (*Rev. Telecomun.* (Madrid), vol. 5, pp. 9–29; December, 1949.) Study of cathode-follower circuits for audio-frequency, low-frequency and high-frequency amplifiers, attenuators and impedance-matching units.

621.396.645 2750

Distributed Amplifiers: Practical Considerations and Experimental Results—W. H. Horton, J. H. Jasberg, and J. D. Noe. (PROC. I.R.E., vol. 38, pp. 748–753; July, 1950.) Experimental results are presented corroborating the predictions made in an earlier (3375 of 1948). The causes of deviation from the idealized case are (*a*) attenuation due to coil losses, (*b*) attenuation due to grid losses, (*c*) grid- and anode-lead inductance, (*d*) capacitance distributed throughout the transmission-line coil windings. These effects can be corrected by using paired-anode circuits, negative-mutual circuits, or bridged-T circuits. The pass bands dealt with are of the order of 200–300 Mc.

621.396.645:621.396.822 2751

Noise Suppression in Triode Amplifiers—A. van der Ziel. (*Canad. Jour. Res.*, vol. 28, pp. 189–198; June, 1950.) A survey is given of recent work on noise suppression in triode amplifier stages. A theory is developed, in which the noise factor is expressed in terms of four complex quantities g_0, g_1, i_0 and i_1, g_0 and g_1 are the complex transconductances in the cathode lead and in the anode lead, respectively; i_0 and i_1 are the Fourier components of the noise currents flowing in these leads, respectively. These quantities are complex owing to transit time effects. The theory is developed under the assumption that i_0 and i_1 are completely correlated. Experiments indicate that no complete noise suppression is possible if there is no feedback; according to the above theory this means that the real part of $g_0-g_1i_0/i_1$ is positive. Knol and Versnel showed recently that complete noise suppression can always be obtained under the above assumption of complete correlation if a suitable amount of external feedback is applied. With the help of the above theory it is shown, however, that the available power gain under those circumstances is less than unity.

621.396.645.018.424:621.397.61:621.3.088.7 2752

The Compensation for Phase Errors in Wide-Band Video Amplifiers—A. E. Brain. (*Proc. IEE* (London), Part III, vol. 97, pp. 243–251; July, 1950.) The transient response of multistage amplifiers may be improved by the insertion of several sections of bridged-T or lattice networks. A method is outlined for evaluating the phase characteristic of an amplifier with an arbitrary amplitude characteristic. Application of three suitable phase-correction circuits to a 16-stage amplifier reduced the rise time by about 33 per cent and

the overshoot from over 20 per cent to less than 9 per cent.

621.396.645.094 2753
On the Problem of Distortionless Amplification of D.C. Pulses with an A.C. Amplifier—R. Gauger. (*Zeit. Angew. Phys.*, vol. 2, pp. 179–188; April 1950.) For investigation of transients in a circuit a "transfer function" is found useful. This is defined as the ratio of output to input voltage as a function of time when a step voltage is applied to the circuit; it is therefore dependent on the circuit time-constant. The transfer function is calculated for amplifiers with and without distortion correction and with up to 3 stages. The influence of the RC combinations in cathode and screen-grid circuits is considered. By use of CR or LR correcting networks the transfer function of a RC-coupled amplifier can be made practically independent of time up to half the original time constant. For pulses of duration less than this such an amplifier is suitable. The compensated amplifier has a lower minimum operating frequency and gives very little phase change at low frequencies. Distortion-free amplification can be achieved for square waves of fundamental frequency at least twice as high as the limiting frequency of the non-compensated amplifier.

621.396.645.35:621.317.755 2754
D.C. Amplifier Techniques in Oscillography—Maron. (*See* 2838.)

621.396.822:519.283 2755
Statistical Prediction of Noise—Y. W. Lee, and C. A. Stutt. (*Proc. NEC* (Chicago), vol. 5, pp. 342–365; 1949.) Pertinent results in Wiener's theory of prediction (2465) above and their application to the prediction of filtered noise are discussed. Calculations leading to the required network for prediction of such noise are given in detail. Results in the form of a simultaneous display of predictor input and output waveforms show that the theory provides a useful approach to certain communication problems.

681.142 2756
Feedback in Electrical Analogue [impedance] Chains and Networks—P. Grivet and Y. Rocard. (*Rev. Sci.*, (Paris), vol. 87, p. 85; April and June, 1949.) The introduction of reaction into such circuits extends their mathematical application.

621.314.3† 2757
The Transductor Amplifier [Book Review]—U. Krabbe. Publishers: Ejnar Munkesgaard, Copenhagen, 1949, 176 pp., Dan. kr. 22. Obtainable from Bonniers, 605 Madison Ave, New York 22, at $5.50. (*Electronics*, vol. 23, p. 132; August, 1950.) "An excellent treatise on saturable-core reactors and their applications. The author, a competent mathematician, has shown rare ability in expressing equations in words prior to resorting to formulas . . . It . . . will constitute an invaluable addition to any engineering library."

621.318.42 2758
The Theory and Design of Inductance Coils. [Book Review]—Publishers: Macdonald, London, 180 pp., 18s. (*Electrician*, vol. 145, p. 425; August 18, 1950.) "The object of this book is to explain, in general terms, the underlying theory on which the design of inductance coils is based, and then to show how the theory can be simplified by the use of certain approximations and to what extent they are justified . . . It is very well produced, carries a small, but useful, bibliography and should be a valuable reference work."

GENERAL PHYSICS

535.222 2759
A Measurement of the Velocity of Light—R. A. Houstoun. (*Proc. Roy. Soc. A*, vol. 63, Part 1, pp. 95–104; 1949–1950.) Full paper. Short account abstracted in 1896 of September.

535.314 2760
Improvement of the Optical Schlieren Method by Minimum Ray Indication—H. Wolter. (*Ann. Phys. Lpz.*, vol. 7, pp. 182–192; April 1, 1950.)

537.311.33:621.314.634 2761
Experimental Examination of Rectifier Theory as Applied to the Selenium Rectifier—Henkels. (*See* 2798.)

537.312.8:[539.23+669-426 2762
The Conductivity of Thin Wires in a Magnetic Field.—R. G. Chambers. (*Proc. Roy. Soc. A*, vol. 202, pp. 378–394; August 7, 1950.) A thin metal wire or film has a lower electrical conductivity than the bulk material if the thickness is comparable with the electronic mean free path. This problem is examined from the kinetic-theory standpoint and the conclusions are applied to the case of a thin wire in an axial magnetic field. Experimental results are given which agree with the theoretical predictions.

537.525:[537.542.2+536.49 2763
The Role of Cathode Temperature in the Glow Discharge—H. Jacobs and J. Martin. (*Jour. Appl. Phys.*, vol. 21, pp. 681–685; July, 1950.) A study of the effect of the temperature of oxide-coated cathodes on cold-cathode glow discharges in neon, argon and neon/argon and Hg-vapor/argon mixtures.

537.562:538.561 2764
Unstable Oscillations in an Electron Gas—K. G. Malmfors. (*Ark. Fys.*, vol. 1, Part 6, pp. 569–578; March 15, 1950. In English.) An analytical treatment of the problem of electron beams in a magnetic field. At high densities an appreciable part of the electron current is collected by negative electrodes and noise level is high, indicating the existence of an energy-interchange mechanism other than or dinary collision; unstable oscillations exist at all frequencies. Such effects may afford a possible explanation of solar and galactic noise.

538.31:538.214:621.396.677 2765
The Effective Permeability of an Array of Thin Conducting Disks—G. Estrin. (*Jour. Appl. Phys.*, vol. 21, pp. 667–670; July, 1950.) "When an alternating magnetic field is parallel to the disk faces, the field is undisturbed and the relative permeability coefficient is unity. When the alternating magnetic field is normal to the disk faces, circulating currents are induced on them. The boundary-value problem of determining the current distribution on a single perfectly conducting disk is carried out in detail for the case where the disk diameter is small compared to the wave-length. This current distribution is found to be representable by a magnetic dipole. If the disks in an array are far enough apart to neglect interaction, a simple summation of the dipole moments shows the array to have a diamagnetic susceptibility in the direction normal to the disk faces. Combining this result with an expression for the dielectric coefficient, which was developed earlier by Kock [2176 of 1948] the constants of the anisotropic array are completely specified."

538.52/.53 2766
Self and Mutual Inductance of a Spherical Metal Shell and of an Endless Solenoid—A. Colombani. (*Compt. Rend. Acad. Sci.*, (Paris, vol. 230, pp. 2158–2160; June 19, 1950.) Simple formulas, which may be of practical importance in high-frequency work, are derived.

538.566:535.421 2767
Rigorous Theory of the Diffraction of Plane Electromagnetic Waves at a Perfectly Conducting Circular Disk and at the Circular Aperture in a Perfectly Conducting Plane Screen—J. Meixner and W. Andrejewski. (*Ann. Phys. Lpz.*, vol. 7, pp. 157–168; April 1, 1950.) A rigorous solution which satisfies the radiation and boundary conditions and facilities numerical calculation is obtained by representing the em field by means of the Hertzian vector potential and developing the expression for the wave in the form of spheroidal functions. The field and the induced-current distribution in the diffracting disk are fully investigated for the particular case of relatively long waves. The complementary problem of diffraction a a circular aperture in a screen of infinite extent may be treated similarly, by virtue of the validity of the generalized Babinet principle.

538.566:537.562 2768
Electro-Magneto-Ionic Waves—V. A. Bailey and K. Landecker. (*Nature* (London), vol. 166, pp. 259–261; August 12, 1950.) Experiments have been made, using gas-discharge tubes subjected to magnetic fields to test the theory that discrete frequency bands exist in which em waves can grow in an ionized medium, developing strong em noise from initially small random perturbations. Various gases, pressures and electrode arrangements were used. For fields ≥ 100 gauss applied along the tube the expected bands always appeared; some observed noise intensities are shown graphically. From the positions of the bands conclusions are drawn regarding the details of wave propagation. Observations were also made on a thyratron with magnetic field applied transversely. The experiments demonstrate the value of the theory and supply a rough model of a sunspot emitter of enhanced solar noise. See also 1665 of July (Bailey and Roberts), 2785 and 3406 of 1949 (Bailey).

548.232:538.221 2769
Oriented Crystals: their Growth and Their Effects on Magnetic Properties—W. Morrill. (*Gen. Elec. Rev.*, vol. 53, pp. 16–21; August, 1950.) Practical use of the anisotropic properties of metals is well advanced and the controlled growth of oriented crystals has produced exceptional magnetic properties in certain commercial materials. Study of crystal orientation and growth is proceeding in many laboratories and it is hoped that eventually any degree of preferred crystal orientation in any magnetic material will be commercially practicable.

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

523.2/.8:538.12 2770
The Hydromagnetic Equations—W. M. Elsasser. (*Phys. Rev.*, vol. 79, p. 183; July 1, 1950.) Using "Maxwellian" electrodynamics equations analogous to the hydrodynamic equations are derived for the currents and associated magnetic fields carried by cosmic fluids. These phenomena are of interest for solar, stellar and sunspot magnetism, geomagnetism, magnetic fields in stellar atmospheres and in interstellar space and the related problem of galactic radio noise.

523.841.2:538.12 2771
Stellar Magnetic Fields—H. W. Babock. (*Nature* (London), vol. 166, pp. 249–251; August 12, 1950.) An account of observations of the magnetic fields of certain variable stars. The star HD 125248 appears to be a magnetic dipole oscillator, with a fundamental frequency 1.25 microcycles/sec, radiating about 10^{12} kw on both fundamental and secondary harmonic.

537.562:538.566 2772
Electro-Magneto-Ionic Waves.—Bailey and Landecker. (*See* 2768.)

551.51:535.326]:621.396.11 2773

Determination of Modified Index-of-Refraction over the Gulf of Mexico from Radio Data—A. W. Straiton and A. H. LaGrone. (*Jour. Appl. Phys.*, vol. 21, pp. 661–666; July, 1950.) Measurements of signal strength and phase of 3.2-cm waves for a 26.5-mile over-sea path were made during June and July, 1949. The radio data are analysed, using Macfarlanes theory (3487 of 1948) to give the modified refractive-index curves, which are compared with those deduced from meteorological observations.

551.510.535+523.5 2774

A Comparison of Meteor Activity with Occurrence of Sporadic E Reflections—V. C. Pineo. (*Science*, vol. 112, pp. 50–51; July 14, 1950.) Previously presented evidence (*ibid.*, vol. 110, p. 280; 1949.) that the echo from a meteor trail differs in character from a sporadic-*E* reflection is supported by a statistical study of continuous observations made at the National Bureau of Standards from November, 1, 1948 to April 30, 1949. Sporadic-*E* is regarded as long-duration abnormality, as distinct from ionization bursts, and extreme care was taken to ensure that only reflections of true sporadic-*E* type were counted. Monthly average values of (*a*) hourly rate of meteor reflections, and (*b*) percentage of time of occurrence of sporadic-*E* reflections, show characteristic maxima at about 0600 EST and midday respectively. A scatter diagram gives no indication of correlation between the two quantities. Day-to-day curves for the month of January show no similarity. The data thus indicate that sporadic-*E* reflections are unrelated to meteor phenomena, at least to those detectable on 27.2 Mc.

551.510.535 2775

Data on the F_2 Layer of the Ionosphere [analyzed] according to the Parabola Model—E. Theissen. (*Naturewiss.* vol. 37, pp. 334–335; July, 1950.) Diurnal, seasonal and long-term ionospheric variations observed at two German stations are examined.

551.594.51 2776

On the Origin of Ten Centimeter Radiation from the Polar Aurora—P. A. Forsyth, W. Petrie, and B. W. Currie. (*Canad. Jour. Res.*, vol. 28, pp. 324–335; May, 1950.) Short-lived bursts of 10-cm radiation from auroral displays have been received by radar equipment. The sources of continuous radiation from a partially ionized medium are briefly discussed. From a knowledge of the constants of the equipment used it is deduced that the power density at the receiver is at least 2×10^{-10} w/m^2, and it seems that the most likely source of this radiation is a plasma oscillation of the ionized volume associated with the auroral display. If this is so, the electron density in localized regions must be of the order of $10^{11}/cm^3$.

521.030:537.5 2777

Cosmical Electrodynamics [Book Review]—H. Alfvén. Publishers: Clarendon Press, Oxford and Oxford University Press, London, 1950, 238 pp., 25s. (*Nature* (London), vol. 166, p. 243; August 12, 1950.) "A short general survey is followed by three chapters discussing the motion of charged particles in a magnetic field, electric discharges, and the magneto-hydrodynamic waves which Alfvén himself first discovered. The ideas developed in these three chapters are then applied in a further three chapters to solar physics (sunspots, chromospheric and coronal temperatures, prominences, etc.), magnetic storms and auroras, and cosmic radiation."

LOCATION AND AIDS TO NAVIGATION

621.396.9 2778

Thunderstorm Tracks by Radar—R. F. Jones. (*Weather* (London), vol. 5, pp. 224–225; June, 1950.) Radar photographs taken near Dunstable of thunderstorms at Evesham and Birmingham on July 13, 1949 are shown and discussed.

621.396.9:531.761 2779

Theoretical Limit to Time-Difference Measurements—Richman. (*See* 2824.)

621.396.933 2780

Traffic-Handling Capacity of Paired-Pulse Coding for 100-Channel Distance-Measuring Equipment (DME)—C. J. Hirsch. (*Proc. NEC* (Chicago), vol. 5, pp. 366–386; 1949.) See 1918 of September.

621.396.933 2781

Radio Aids to Navigation at the Ministro Pistarini Airport [Buenos Aires]—P. N. Guzzi. (*Rev. Telegr.* (Buenos Aires), vol. 37, pp. 307–312; June, 1949.) The aids provided, chosen to conform to ICAO recommendations, will include GCA and an instrument landing system.

621.396.933 2782

Instrumental Landing System for Aircraft—A. N. Bhattacharyya. (*Indian Jour. Phys.*, vol. 23, pp. 13–18; January, 1949.) General discussion of a system using the interference of ultra-high-frequency waves radiated from two antennas excited in the same phase with a common frequency.

621.396.933 2783

Microwave Radio Blind-Landing Systems for Aircraft—A. N. Bhattacharyya. (*Indian Jour. Phys.*, vol. 23, pp. 88–92; February, 1949.) Two sharply defined beams rotating in a plane inclined to the earth's surface at the glide angle are produced respectively by two horn antennas rotating in opposite directions. The beams are synchronized to intersect in the vertical plane midway between the antennas thus defining a glide path. Operating frequency is of the order of 20 kMc.

MATERIALS AND SUBSIDIARY TECHNIQUES

531.788.12 2784

A Rotary McLeod Gauge—M. Axelbank. (*Rev. Sci. Instr.*, vol. 21, pp. 511–513; June, 1950.) The new model described is improved in respect of portability, robustness and ease of operation.

531.788.7 2785

Extension of the Low-Pressure Range of the Ionization Gauge—R. T. Beyard and D. Alpert. (*Rev. Sci. Instr.*, vol. 21, pp. 571–572; June, 1950.) The new model described has been used to measure pressures of the order of 10^{-10} mm Hg.

538.221:546.56.723.722 2786

Magnetic Properties and Structure of the Quadratic Phase of Ferrite of Copper—L. Weil, F. Bertaut, and L. Bochirol. (*Jour. Phys. Radium*, vol. 11, pp. 208–212; May, 1950.)

538.221:621.317.411.029.5 2787

Determination of the Apparent Permeability and *Q* Factor of a Magnetic Powder at High Frequency—A. Colombani. (*Jour. Phys. Radium*, vol. 11, pp. 201–207; May, 1950.) The resultant internal and external fields are first calculated for an isolated particle in a high-frequency magnetic field. The results are applied to a uniform distribution of particles within a medium. From the complex permeability found, the *Q* factor and flux reduction factor are easily deduced. Calculated values, dependent on frequency, conductance and grain size, are in good agreement with experimental results. See also 1172 of June.

538.221:669.231.15 2788

Magnetic Properties of Platinum-Iron Alloys: Part 2—A. Kussmann and G. von Rittberg. (*Ann. Phys., Lpz.*, vol. 7, pp. 173–101; April 1, 1950.) For alloys containing 50 to 63 per cent Pt by weight, magnetostriction effects are the highest yet observed in ferromagnetic materials. Optimum properties for permanent magnets are obtained when the Pt content is 70 per cent. Magnetostriction in this case is very small.

538.221:669.231.74 2789

Ferromagnetic Platinum-Manganese Alloys—M. Auwärter and A. Kussmann. (*Ann. Phys., Lpz.*, vol. 7, pp. 169–172; April 1, 1950.) The ferromagnetic properties exhibited by Pt-Mn alloys containing 6 to 16 per cent Mn by weight are attributed to the ordered arrangement of the atoms in the mixed crystals as Pt_3Mn. Magnetic-saturation and thermal-expansion curves, lattice constants and transition temperatures are given.

538.652:669.018.58 2790

Evaluation of the Magnetostrictive Properties of Hiperco—H. Sussman and S. L. Ehrlich. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 499–506; July, 1950.) A description of tests made to evaluate the suitability of the alloy as a material for transducers. The performance criteria are established, and the properties and performance of hiperco, nickel and permendur are compared. For remanence operation hiperco is satisfactory for hydrophone use, but it is inferior to the other materials for high-power underwater projection. Its performance is improved by polarizing above remanence.

546.217:621.317.335.3.029.64 2791

The Permittivity of Air at a Wavelength of 10 Centimeters—Phillips. (*See* 2827.)

546.471.61:537.311+537.323+538.632 2792

Electronic Processes in Zinc Fluoride and in the Manganese-Activated Zinc Fluoride Phosphor—J. H. Crawford, Jr, and F. E. Williams. (*Jour. Chem. Phys.*, vol. 18, pp. 775–780; June, 1950.) Measurements of the temperature dependence of electrical conductivity and thermal emf for ZnF_2 and ZnF_2-Mn, and of the Hall coefficient and rectifying power at 25°C for ZnF_2.

546.472.21:535.37 2793

The Poisoning of Cathodoluminescence in Silver-Activated Cubic Zinc Sulfide—S. Larach. (*Jour. Chem. Phys.*, vol. 18, p. 896; June, 1950.) Small amounts of Co, Fe or Ni sulphates were crystallized together with the ZnS-Ag phosphor. The poisoning effect was about the same for all three impurities. Cathode rays were used for excitation.

548.0:537 2794

Ferroelectric Crystals—B. Matthias. (*Helv. Phys. Acta*, vol. 23, pp. 167–170; February 3, 1950. In German.) Fundamental research carried out at the E. T. H., Zürich, is described briefly. The possibility of finding other ferroelectric crystals isomorphic with $BaTiO_3$ is investigated.

549.514.51:548.523 2795

Growing Large Quartz Crystals—A. C. Walker and E. Buehler. (*Indust. Eng. Chem.*, vol. 42, pp. 1369–1375; July, 1950.) Full paper. Summary abstracted in 411 of 1949.

621.3.015.5:546.217 2796

A Note on Ultra-High-Frequency Gas Breakdown—W. A. Prowse. (*Proc. IEE*,

(London), Part III, vol. 97, pp. 253–254; July, 1950.) Some results obtained by Pim (2246 of 1949) show breakdown voltages which increase as the gap width is reduced. An explanation is here given as to why the spark, under such conditions, does not simply transfer to a point of greater gap width.

621.3.087.45 2797

Closed-Cycle Recording Oscillographs—B. Ciscel and R. Ruhland. (*Proc. NEC*, vol. 5, pp. 4–10; 1949.) Review of available equipment and description of an 8-channel pen recorder, with servo-moter pen drive, for use in flight tests.

621.314.634:537.311.33 2798

Experimental Examination of Rectifier Theory as Applied to the Selenium Rectifier—H. W. Henkels. (*Proc. NEC* (Chicago), vol. 5, pp. 23—39; 1949.) Recent work at the University of Pennsylvania on the correlation of rectifier theory with experiment is examined. The variables in Schottky's theory are treated individually. The electrical properties of single crystals, as well as microcrystalline specimens, are examined in their relation to the Se rectifier. To explain bulk properties, a model of microcrystalline selenium must possess layers of high resistance at crystal grain boundaries, and surface layers on the crystallites of quite low resistance.

621.315.592†:539.23 2799

Concerning the Theory of Photoconductivity in Infra-red-Sensitive Semiconducting Films—E. S. Rittner. (*Science*, vol. 111, pp. 685–688; June 23, 1950) Critical discussion of various theories, with a more general explanation of the effects observed in such films which avoids the difficulty of the exact balancing of impurities.

621.315.612.4:546.431.82 2800

The Dielectric Properties of Barium Titanate—R. E. Averbukh and M. S. Kosman. (*Zh. Eksp. Teor. Fiz.*, vol. 19, pp. 965–970; November, 1949.) The dependence of the dielectric constant of $BaTiO_3$ on temperature and on field strength is investigated by a new ballistic method. The expression for the constant consists of two terms which vary differently.

621.315.612.6:537.311 2801

Electrical Conduction in Glass—P. L. Kirby. (*Brit. Jour. Appl. Phys.*, vol. 1, pp. 193–202; August, 1950.) The mechanism of electrical conduction in glass is discussed in the light of modern theories of its atomic structure. Variation of conductivity with composition is explained by reference to the valency requirements of the network atoms, and the temperature variation of conductivity is examined. The relative magnitudes of the dielectric absorption current and the true conduction current are considered, and the total loss angle is calculated for various temperatures to illustrate the transition from a dielectric to an ionic conductor.

621.315.616.7 2802

A New Dry-Type Insulation for Instrument Transformers.—R. A. Pfuntner, R. E. Franck, and F. R. D'Entremont. (*Elec. Eng.*, vol. 69, pp. 594–599; July, 1950.) Butyl, a rubber-like material, can be moulded completely round core and coils; its dielectric properties are excellent over a wide range of temperature and humidity and it is chemically stable.

621.395.625.3:681.6 2803

A New Magnetic Record Duplicating Process—M. Camras. (*Proc. NEC* (Chicago), vol. 5, pp. 258–261; 1949) A rapid contact-printing process in which the blank is held against a master tape while the two are subjected to a high-frequency magnetic field. See also 2804 below (Herr).

621.395.625.3:681.6 2804

Duplication of Magnetic Tape Recordings by Contact Printing—R. Herr. (*Proc. NEC* (Chicago), vol. 5, pp. 262–268; 1949.) Discussion of a method identical in principle with that noted in 2803 above, and brief description of practical equipment. The method is not limited to tape records, but can be applied to records on disks, drums, etc. It does not seem applicable to the duplication of records on wire.

621.946.148.12 2805

High-Voltage and Electrolytic Drilling of Diamond Dies—(*Machinery* (London) vol. 76, No. 1961, pp. 743–744; May 25, 1950.) Short account of method noted in 3944 of 1947.

666.1.037.5:539.319 2806

Stresses in Glass/Metal Seals: Part 1—The Cylindrical Seal—F. W. Martin. (*Jour. Amer. Ceram. Soc.*, vol. 33, pp. 224–229; July 1, 1950.) Consideration of viscous flow during cooling of a beaded wire seal following annealing treatment leads to a modification of the theory of Hull and Burger (1184 of 1935); good agreement is then obtained between theoretical and experimental values of stress in beaded wire seals. Cylindrical seals with the metal outside are also considered. The expansion necessary for the best match depends on the geometry of the seal. In general, metal glass seals should be annealed at a temperature above that used for the glass alone.

537.228.1:548.0 2807

Piezoelectric Crystals and their Application to Ultrasonics [Book Review]—W. P. Mason. Publishers: D. Van Nostrand, New York, 508 pp., $7.50. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 519–520; July, 1950.)

MATHEMATICS

519.242:621.396.1 2808

An Extension of Wiener's Theory of Prediction—L. A. Zadeh and J. R. Ragazzini. (*Jour. Appl. Phys.*, vol. 21, pp. 645–655; July, 1950.) The signal (message) component of the given time series is assumed to consist of two parts, (*a*) a non-random function of time which is representable as a polynomial of degree not greater than a specified number n and about which no information other than n is available; and (*b*) a stationary random function of time which is described statistically by a given correlation function. (In Wiener's theory, the signal may not contain a non-random part except when such a part is a known function of time.)

The impulsive response of the predictor or, in other words, the weighting function used in the process of prediction is required to vanish outside of a specified time interval $0 \leq t \leq T$. (In Wiener's theory T is assumed to be infinite.)

The theory developed in this paper is applicable to a broader and more practical class of problems than that covered in Wiener's theory. As in Wiener's theory, the determination of the optimum predictor reduces to the solution of an integral equation which, however, is a modified form of the Wiener-Hopf equation. A simple method of solution of the equation is developed. This method can also be applied with advantage to the solution of the particular case considered by Wiener. The use of the theory is illustrated by several examples of practical interest." See also 2465 above.

681.142 2809

Linear Electronic Analog Computer Design—C. A. Meneley and C. D. Morrill. (*Proc. NEC* (Chicago), vol. 5, pp. 48–63; 1949.) Discussion of problems of design and a description of a complete computer with power supplies, housed in a single 6 ft. × 19 in. cabinet.

681.142 2810

Feedback in Electrical Analogue [impedance] Chains and Networks—P. Grivet and Y. Rocard. (*Rev. Sci.*, (Paris) vol. 87, p. 85; April-June, 1949.) The introduction of feedback in such circuits extends their mathematical application.

681.142 2811

An Electronic Integral-Transform Computer and the Practical Solution of Integral Equations—H. Wallman. (*Jour. Frank. Inst.*, vol. 250, pp. 45–61; July, 1950.) Description of the principle and discussion of the applications of a proposed instrument performing computations in about 0.1 sec and presenting results graphically on a cathode-ray tube screen.

681.142:512.25 2812

A Computer for Solving Secular Equations—J. F. Storm. (*Proc. NEC* (Chicago), vol. 5, pp. 98–106; 1949.) A manually operated analogue computer for obtaining the real roots of a 3-by-3 set of secular equations. Modifications required for automatic operation are discussed.

681.142:621.314.3† 2813

Magnetic Amplifier Studies on the Analog Computer—Harder, Hamilton, Aldrich, Carleton, and McClure. (*See* 2731.)

681.142:621.389 2814

The Photoformer in Anacom Calculations—H. W. Schultz, J. F. Calvert, and E. L. Buell (*Proc. NEC* (Chicago), vol. 5, pp. 40–47; 1949.) Description of a device for generating a wide variety of functions by making a cathode-ray beam follow the edge of an appropriate mask, with discussion of its use as a nonlinear element in an analogue computer.

517.31/.36+517.7](083.81) 2815

Integraltafel. Erster Teil: Unbestimmte Integrale [Book Review]—W. Gröbner and N. Hofreiter. Publishers: Springer-Verlag, Vienna, 1949, 166 pp. $5.40. (*Quart. Appl. Math.*, vol. 7, p. 474; January, 1950.) "This table of indefinite integrals appears to be more complete than others generally available. There are three sections. . . entitled Rational Integrands . . . , and Transcendental Integrands . . ." Part 2, on definite integrals, is in preparation.

517.512.2+517.942.82 2816

Fourier Methods [Book Review]—P. Franklin. Publishers: McGraw-Hill Book Co., New York, 1949, 289 pp., $4.00. (*Jour. Frank. Inst.*, vol. 249, pp. 258–259; March, 1950.) This is a book written for students. "The author broadly interprets Fourier methods as any analysis or synthesis of functions by a linear process applied to sines, cosines, or to complex exponentials . . . [He] has successfully treated the subject of Fourier series and transforms and Laplace transforms in an introductory manner which . . . is adequate for many practical problems."

517.564.2(083.5) 2817

Tables of Inverse Hyperbolic Functions [Book Review]—Computation Laboratory, Harvard University. Publishers: Harvard University Press, Cambridge, Mass., 1949, 290 pp., $10.00. (*Quart. Appl. Math.*, vol. 7, p. 475; January, 1950.) First and second differences are given, and the functions are tabulated to 9 decimal places.

517.564.3(083.5) 2818

Tables of Bessel Functions of Fractional Order: Vol. 2 [Book Review]—Computation Laboratory, National Bureau of Standards. Publishers: Columbia University Press, New York, 1949, 365 pp., $10.00. (*Quart. Appl. Math.*, vol. 7, p. 475; January, 1950.) $I_\nu(x)$ is tabulated for $\nu = \pm\frac{1}{4}, \pm\frac{1}{3}, \pm\frac{2}{3}, \pm\frac{3}{4}$, x ranging

from 0 to 13 for the negative values of ν and from 0 to 25 for the positive values of ν. $e^{-x}\,I_\nu(x)$ is tabulated for the same values of ν and for x ranging from 25 to 30,000. Functions are tabulated to 10 decimal places or 10 significant figures. Auxiliary tables facilitate interpolation in the x and ν directions.

517.564.3(083.5) 2819

Tables of the Bessel Functions of the First Kind of Orders Fifty-Two through Sixty-Three [Book Review]—Computation Laboratory, Harvard University. Publishers: Harvard University Press, Cambridge, Mass., 1949, 544 pp., $8.00. (*Quart. Appl. Math.*, vol. 7, p. 479; January, 1950.) $J_{52}(x)$, $J_{53}(x)$, ... $J_{63}(x)$ are tabulated to 10 decimal places for values of x ranging from 0 to 100 in steps of 0.01.

517.7 2820

Anwendung der elliptischen Funktionen in Physik und Technik [Book Review]—F. Oberhettinger and W. Magnus. Publishers: Springer, Berlin, 1949, 126 pp., paper cover, 15.60 DM, bound, 18.30 DM. (*Naturwiss*, vol. 37, p. 237; May, 1950.) Includes a series of examples of two-dimensional problems in electrostatics and hydromechanics, particularly field calculations, and current flow in channels of rectangular or elliptical cross-section, and Tchebycheff approximations in filter circuit theory.

517.9 2821

Partial Differential Equations in Physics [Book Review]—A. Sommerfeld. Publishers: Academic Press, New York, 1949, 335 pp., $5.80. (*Science*, vol. 111, p. 414; April 21, 1950.) A translation by E. G. Straus of the sixth volume of Somerfeld's "Lectures on Theoretical Physics." "The last chapter deals with the propagation of radio waves and serves as an illustration of many of the general methods developed in earlier chapters. The chief merit of the book lies in its skilful handling of complex problems, by the use of a minimum of mathematical formalism and a maximum of physical intuition."

518.12 2822

Numerical Calculus [Book Review]—W. E. Milne. Publishers: Princeton University Press, Princeton, N.J., 1949, 393 pp., $3.75. (*Quart. Appl. Math.*, vol. 7, p. 478–479; January, 1950.) An elementary presentation, covering approximations, interpolation, finite differences, numerical integration and curve fitting.

MEASUREMENTS AND TEST GEAR

531.761:621.387.424† 2823

A Direct-Reading Device for Measuring Dead Time and Recovery Time of Geiger Counters—Epprecht. (*See* 2864.)

531.761:621.396.9 2824

Theoretical Limit to Time-Difference Measurements—D. Richman. (*Proc. NEC* (Chicago), vol. 5, pp. 203–210; 1949.) Theoretical relations are derived between the accuracy with which a signal may be located in time; and the various factors which determine the accuracy. These are (*a*) signal noise ratio, (*b*) modulation bandwidth, (*c*) signal duration, (*d*) signal frequency. The relations can be used to compute the signal noise ratio required in systems of prescribed bandwidth, signal duration, and accuracy.

621.3.089.6:621.396.615.085.41 2825

Automatic Calibration of Oscillator Scales—W. J. Means and T. Slonczewski. (*Proc. NEC* (Chicago), vol. 5, pp. 217–221; 1949.) Long frequency scales used in heterodyne oscillators are calibrated by recording photographically on a strip of motion-picture film the image of a master scale which continuously indicates the instantaneous frequency of the oscillator.

621.317.31/.32:621.396.645 2826

Notes on Voltage, Current and Charge Measurements by Means of Valve Amplifiers—W. Böer. (*Ann. Phys., Lpz.*, vol. 7, pp. 193–208; April 1, 1950.) Two parameters are defined by means of which different types of apparatus can be compared: (*a*) electrical resolving power, which is a measure of the least difference detectable between two currents of 1-sec duration; (*b*) pulse sensitivity. Estimates are made of the disturbing effect of fluctuations originating in batteries, resistors and valves, and noise effects in grounded-grid and free-grid valves are considered. Practical measurement limits for voltage, current and charge are deduced. Some fifty references are given.

621.317.335.3.029.64†:546.217 2827

The Permittivity of Air at a Wavelength of 10 Centimeters—W. E. Phillips. (Proc. I.R.E., vol. 38, pp. 786–790; July, 1950.) Measurements of the permittivity of air as a function of water-vapor content, at atmospheric pressure and temperature, support the results of previous workers regarding the important effect of atmospheric water-vapor content on the refraction of ultra-high-frequency waves. Measurements on dry air and water vapor at reduced pressure are also recorded. Permittivity is determined by comparing the wavelengths of standing waves in a cylindrical cavity resonator when evacuated to a pressure of 0.01 mm Hg and when containing the air sample under test. The following values for permittivity were obtained: dry air at 759.09 mm Hg and 25.5°C, 1.0005548; dry air at reduced pressure and 22°C, 1.000393_4 at 555.48 mm Hg and 1.000129_8 at 180.08 mm Hg; moist air, 1.000806 at 752.45 mm Hg, 22°C and 100 per cent humidity, falling to 1.000668 at 756.45 mm Hg, 19°C and 55.7 per cent humidity.

621.317.361 2828

On the Problem of Unequivocal Frequency Measurement by Comparison with Fixed Standard Frequencies—H. M. Schmidt. (*Zeit. Angew. Phys.*, vol. 2, pp. 219–223; May, 1950.) In the method discussed the unknown frequency f_x is heterodyned with (*a*) a suitable harmonic nf_0 of the standard frequency f_0, and (*b*) a second standard-frequency source f_0 with a known phase displacement ϕ. The phase difference of the difference frequencies produced is $fn\phi$ according as f_x is higher or lower than nf_0. The number n is given by the ratio of the phase angle for the difference frequencies to that for the fundamentals.

621.317.361:621.396.611.21 2829

Crystal Resonators as Frequency Substandards—F. J. M. Laver. (*Proc. IEE* (London), Part III, vol. 97, p. 252; July, 1950.) Discussion on 1453 of July.

621.317.42 2830

Notes on the Theory and Practice of Magnetic Field-Strength Comparators of the Förster Type—M. Wurm. (*Zeit. Angew. Phys.*, vol. 2, pp. 210–219; May, 1950.) Discussion of the principle of and design improvements for the premagnetized coil-type meter. See also 1470 of 1941 (Förster).

621.317.714.011.6 2831

The Measurement of the Time Constant of a Critically Damped Meter—S. F. Pearce. (*Jour. Sci. Instr.*, vol. 27, pp. 202–203; July, 1950.) The performance of critically damped meters, such as are required as the final indicating instrument in a receiver used for the measurement of radio interference, is analyzed and a simple method is described for measurement of the time constant.

621.317.714.029.62 2832

Electrodynamic Ammeter for Very High Frequencies—(*Tech. Bull. Nat. Bur. Stand.*, vol. 34, pp. 103–104; July, 1950.) Short description of an instrument developed at the National Bureau of Standards by M. Solow. It consists essentially of a coaxial transmission line with a copper wire ring about 1 cm in diameter suspended between the inner and outer conductors by a quartz fibre. When current flows in the line a torque is exerted on the ring and its value is indicated optically. The instrument is calibrated by measurements at both 300 Mc and 150 Mc.

621.317.729:621.396.677 2833

Electrolytic-Tank Measurements for Microwave Metallic Delay-Lens Media—S. B. Cohn. (*Jour. Appl. Phys.*, vol. 21, pp. 674–680; July, 1950.) The low-frequency index of refraction of a delay-lens medium can be calculated from electrolyte-tank measurements on single elements. The proximity between adjacent elements is taken into account. Apparatus and method are described and results are tabulated for three types of delay-lens structure.

621.317.73 2834

Admittance Analyzer—W. B. Bernard. (*Electronics*, vol. 23, pp. 107–109; August, 1950.) The admittance to be measured is connected across a tuned circuit which is then retuned; the change of capacitance to restore resonance gives the unknown susceptance, and the conductance is calculated from $G=(E/e-1)/R$, where E is the voltage across the retuned circuit and a known resistance R in series with it, and e is the voltage across the retuned circuit alone. Resistance range was found to be 10 Ω to 1 MΩ at frequencies up to 1 Mc. At higher frequencies the upper limit is $1/f$ MΩ, where f is in Mc. A detailed circuit diagram is given of an instrument which has proved very suitable for antenna measurements on site.

621.317.73.029.62/.63 2835

Discontinuities in Concentric-Line Impedance-Measuring Apparatus—M. H. Oliver. (*Proc. IEE* (London), Part III, vol. 97, p. 242; July, 1950.) Discussion on 1188 of June.

621.317.73.083.5 2836

Correction Factors for Slotted Measuring Lines at Very High Frequencies—R. G. Medhurst and S. D. Pool. (*Proc. IEE* (London), Part III, vol. 97, pp. 223–230; July, 1950.) Errors due to mechanical irregularities usually have a repeatable effect. A correction factor varying with the position along the line can be derived. The initial determination is lengthy but the result is a multiplying factor that can be tabulated.

621.317.733:621.392.43.029.62 2837

A V.H.F. Match Meter—P. G. Sulzer. (*TV Eng.*, vol. 1, pp. 4–6; July, 1950.) The meter includes two bridges, and when connected between a low-power radio-frequency source (10–250 Mc) and an antenna or transmission line it indicates the magnitude of the reflection coefficient. One bridge is used for unbalanced systems, the other for balanced systems, the reference impedances being respectively 52 Ω and 300 Ω. The voltmeters reading the input and null voltages consist of crystal diodes with a switched dc microammeter. Calibration is effected either by comparison with a voltmeter of known accuracy or by connecting selected high-frequency resistors across the test terminals.

621.317.755:621.396.645.35 2838

D.C. Amplifier Techniques in Oscillography—M. Maron. (*Proc. NEC* (Chicago), vol. 5, pp. 11–16; 1949.) Design problems are discussed, and a description is given of a dc

amplifier, developed as a signal amplifier for a cro. Auxiliary circuits, including time bases, are described. Typical applications of the dc amplifier in oscillography are outlined.

621.317.763.029.64:621.396.611.4 2839
A 10-cm Mechanically Swept Spectrometer—P. Andrews. (*Proc. IEE* (London), Part III, vol. 97, pp. 260–261; July, 1950.) Discussion on 2855 of 1949. An instrument for the same frequency, but with an electronic sweep system, is described by P. Bramham.

621.317.79:621.3.018.78† 2840
An Intermodulation Analyzer for Audio Systems—R. S. Fine. (*Audio Eng.*, vol. 34, pp. 11–13, 43; July, 1950.) A description, with detailed circuit diagram, of an instrument for measurement of intermodulation distortion. It is particularly useful for assessing the quality of amplifiers and phonograph pickups.

621.317.79:621.396.67 2841
The Electronically Driven Ripple-Tank as an Aid to Phase-Front Visualization—A. H. Schooley. (*Proc. NEC* (Chicago), vol. 5, pp. 303–314; 1949.) A detailed account of equipment noted in 1979 of September, with numerous photographs of typical patterns.

621.317.799†:621.397.5 2842
Inexpensive Picture Generator—J. R. Popkin-Clurman. (*Electronics*, vol. 23, pp. 102–106; August, 1950.) Light from the raster of a television receiver is transmitted through a transparent test pattern and picked up by a multiplier photocell whose output is amplified and corrected for cathode-ray tube phosphor decay. Video phase-splitting allows positive or negative transparencies to be used. Blanking pulses are added in a mixer whose output is clipped and provides the composite video test-pattern signals, which are suitable for feeding the video section of a television receiver if synchronizing arrangements are available. A separate sweep circuit for providing raster and blanking pulses is described, with detailed diagrams.

621.396.662.029.64 2843
Microwave Attenuators for Powers up to 1000 Watts—H. J. Carlin and E. N. Torgow. (Proc. I.R.E., vol. 38, pp. 777–780; July, 1950.) A broad-band attenuator is described which reduces input powers by a fixed ratio to a low level measurable by a bolometer. The device is a combination of three units: (*a*) a coaxial-line attenuator whose axial conductor penetrates transversely into the main power-carrying coaxial line; this operates on a capacitance-divider principle; (*b*) a metallized-glass coaxial attenuator (348 of 1949) for matching (*a*) to the test line and for equalizing its attenuation with respect to frequency; and (*c*) a tapered-dielectric coaxial load in the main line. Two sets of equipment cover the band 1–10 kMc.

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

534.321.9:539.32 2844
Ultrasonic Measurement Techniques Applicable to Small Solid Specimens—H. J. McSkimin. (*Jour. Acous. Soc. Amer.*, vol. 22, pp. 413–418; July, 1950.) A description of techniques for the measurement of velocity of propagation and attenuation by phase-comparison methods, using either longitudinal or transverse waves. One is a resonance technique, using a pulse input and displaying the addition of in-phase multiple reflections from within the specimen. A more precise technique, using circuit-wave oscillations gated by dc pulses, depends on the cancellation of any order of multiple reflection by a delayed signal derived from the input. The phase shifts at reflecting interfaces may be independently determined. Derivations of the principal formulas used are given and the precautions necessary in the use of polystyrene seals and fused-silica supporting rods are described.

534.321.9:620.179.1 2845
Ultrasonics and Their Use for Non-Destructive Testing of Materials—N. G. Neuweiler. (*Microtecnic* (Lausanne), vol. 4, pp. 37–44 and 60–66; January-February, and March-April, 1950.) Illustrated description of the principles, operation and applications of a flaw detector.

534.321.9:621.398:535.88 2846
Supersonic Control of a Lantern-Slide Projector—S. G. Lutz and G. Rand. (*Proc. NEC* (Chicago), vol. 5, pp. 477–481; 1949.) Equipment is described which enables a lecturer to operate the slide-changing device on a projector by means of a small ultrasonic whistle concealed in a pocket.

535.214.4:535.61–15 2847
The Diaphragm Radiometer—P. E. Weber. (*Optik*, vol. 6, pp. 152–161; March, 1950.) A description is given of an infra-red radiation receiver whose operation is based on the kinetic effect in gases. Thermally modulated radiation is incident on a diaphragm forming one closure of a gas chamber, and the resulting oscillations of the diaphragm produce capacitance variations in one arm of a tuned high-frequency bridge. Using a modulation frequency of 100 cps, radiated power as low as 1.2×10^{-7} w/cm² can be measured, the high-frequency voltage delivered being then 10^{-5}v. Greater sensitivity can be attained by exposing the diaphragm to sound of a frequency which is a multiple of the modulation frequency.

621.3.087.6:534.232:534.321.9 2848
Application of Supersonic Energy to High Speed Electronic Recording—Dana and Van Meter. (*Proc. NEC* (Chicago), vol. 5, pp. 473–476; 1949). See 1561 of August.

621.316.72:537.533 2849
Automatic Regulation of Thermionic Emission—W. Steckelmacher and S. van der Meer. (*Jour. Sci. Instr.*, vol. 27, pp. 189–191; July, 1950.) Continuous control for large changes of emission conditions, such as occur in continuously pumped X-ray tubes or ionization vacuum gauges, is effected by using the change of emission current to develop a correction voltage which is applied, after amplification, to a pair of valves whose anode currents govern the heating current for the electron source. A phase-shift network in the feedback chain prevents the oscillations which sometimes occur when controlling massive filaments.

621.317.083.7 2850
Matrix Telemetering System—N. R. Best. (*Electronics*, vol. 23, pp. 82–85; August, 1950.) 30PTM channels are superimposed on a 1025-Mc carrier with peak power of 4 kw. A 10-kc oscillator in the transmitting (airborne) unit operates a 32-state counter defining 100-μs time intervals for each channel, and transmits a synchronizing pulse to an oscillator counter unit in the receiver. The signals in the various channels are displayed as time-positioned-dots on a blacked-out cathode-ray tube trace and are recorded on continuously running film.

621.317.39 2851
Some Electrical Methods of Measuring Mechanical Quantities—F. J. Woodcock. (*Proc. IEE* (London), Part I, vol. 97, pp. 136–149, Discussion, pp. 149–154; July, 1950.) Full paper, including 87 references. Summary noted in 2306 of November.

621.317.39:531.717.1 2852
Thickness Gage for Moving Material—S. V. Hart and I. W. Rozian. (*Proc. NEC* (Chicago), vol. 5, pp. 83–87; 1949.) An instrument which records the thickness of any non-magnetic material within the range 0.0001–1.0 in. and detects deviations of <1 microinch from a standard. The material is inserted between primary and secondary of a split transformer, the output of which is balanced in a bridge circuit against that of a similar unit holding a standard slat. Magnetic materials can be handled by using a pair of differential transformers.

621.317.755:621.317.39 2853
Multiple-Channel Cathode-Ray Instrumentation of Non-Electrical Quantities—J. N. Van Scoyoc and G. F. Warnke. (*Proc. NEC* (Chicago), vol. 5, pp. 88–97; 1949.) Description of a 24-channel mobile unit using single-beam cathode-ray tubes whose screen patterns are photographed on continuously moving film.

621.365.55† 2854
Heating by Means of High-Frequency Fields: Part 2—Capacitive Heating—M. Stel and E. C. Witsenburg. (*Philips Tech. Rev.*, vol. 11, pp. 232–240; February, 1950.) A formula is derived for the amount of heat generated in unit time in a homogeneous dielectric. Selective heating can be produced when two different dielectrics (e.g. wood and glue) are associated. Industrial applications are discussed. Part 1: 1995 of September.

621.384.6 2855
Principle of an Ion Source for Intense Beams—C. Cassignol. (*Nature* (London), vol. 166, pp. 233–234; August 5, 1950.) The principle used is similar to that of Alfvén's trochotron (1205 of 1948), but field modifications are introduced for concentrating positive ions instead of electrons. The extracting electrode is a short cylinder coaxial with the accelerator tube, and is provided with a circumferential slit and maintained negative. An inhomogeneous magnetic field assists in focusing the ions on to the slit. Observations on this and on a linear type of source support the theoretical assumptions.

621.384.611.1†:615.849 2856
Experiments with a 6-MeV Betatron—K. Gund and W. Paul. (*Nucleonics*, vol. 7, pp. 36–45; July, 1950.) An account is given of the development and construction of a betatron in the electromedical laboratory of Siemens-Reiniger-Werke, Erlangen, Germany. Preliminary physical and biological experiments with the equipment are described, including cancer treatment in human beings.

621.384.611.2† 2857
Extraction of the Electron Beam from a 30-MeV Synchrotron—J. D. Lawson, H. E. Walford, and J. H. Aram. (*Nature* (London), vol. 166, pp. 234–235; August 5, 1950.) Electrons of energy up to 20 Mev have been extracted from the Harwell synchrotron by use of a small shunt coil carrying a pulsed current of up to 6,000 A peak, timed so that the current is a maximum when the electrons enter the shunt. No difficulty is anticipated in applying the method to 30-Mev electrons.

621.387.4† 2858
Scintillation Type Alpha-Particle Detector—A. S. Goldin, E. R. Rohrer, and R. L. Macklin. (*Rev. Sci. Instr.*, vol. 21, pp. 554–557; June, 1950.)

621.387.4† 2859
The Theory and Properties of Low Voltage Radiation Counters—J. A. Simpson, Jr. (*Rev. Sci. Instr.*, vol. 21, pp. 558–568; June, 1950.)

621.387.4†:548.0 2860
Crystal Counters—R. Hofstadter. (PROC. I.R.E., vol. 38, pp. 726–740; July, 1950.) The author's previous survey of this subject (2506 and 2507 of 1949) is extended to cover later developments such as counters using S or Ge crystals.

621.387.424† 2861
Geiger Counter for Civilian-Defense Use—H. D. LeVine, H. J. DiGiovanni, and M. R. Coe. (*Nucleonics*, vol. 6, pp. 56–59; June, 1950.) Description of a simple and relatively cheap counter. The necessary high-voltage supply is obtained from a vibrator operated by a 3-v flashlight battery.

621.387.424† 2862
A Method of Measuring Spurious Counts in Geiger-Müller Counters—D. Willard and C. G. Montgomery. (*Rev. Sci. Instr.*, vol. 21, pp. 520–521; June, 1950.)

621.387.424† 2863
The Velocity of Propagation of the Discharge in Geiger-Müller Counters—H. Saltzmann and C. G. Montgomery. (*Rev. Sci. Instr.*, vol. 21, pp. 548–549; June, 1950.)

621.387.424†:531.761 2864
A Direct-Reading Device for Measuring Dead Time and Recovery Time of Geiger Counters—G. W. Epprecht. (*Helv. Phys. Acta*, vol. 23, pp. 291–298; April 20, 1950. In German.) An RC discharge circuit is used to measure the shortest time interval between successive pulses. Some results obtained with the apparatus are shown.

621.396.9:526.9 2865
Electronic Contour Mapping—R. C. Raymond. (*Proc. NEC* (Chicago), vol. 5, pp. 211–216; 1949.) A stabilized aircraft with a pencil-beam radar set makes several thousand observations per second on the terrain over which it flies. The data are used to print a contour map. Calculations indicate that with efficient equipment contour maps covering 1,000 square miles could be printed in under an hour.

621.398 2866
The Landis & Gyr Audio-Frequency Telecontrol System—(*Bull. Tech. Suisse Romande*, vol. 76, pp. 146–148 and 162–164; June 3 and 17, 1950.) Description of a system particularly suitable for use on power lines and operating on a frequency of 475 or 725 cps. A shorter account was noted in 1744 of August.

681.142:621.385.832 2867
Coordinate Tubes for Use with Electrostatic Storage Tubes—R. S. Julian and A. L. Samuel. (*Proc. NEC* (Chicago), vol. 5, pp. 107–122; 1949.) The system uses two master tubes which separately control the horizontal and vertical displacements of the electron beams in a bank of slave tubes. Control is effected by servo amplifiers, which locate the proper memory positions from their digital address codes in terms of the mechanical positions of target plates contained within the master tubes. Two different types of tube are described, one for sequential operation, the other for a parallel address system.

621.38 2868
An Introduction to Electronics [Book Review]—J. Yarwood. Publishers: Chapman and Hall, London, 329 pp., 28s. (*Electrician*, vol. 145, p. 425; August 18, 1950.) ". . . for those physics and engineering students . . . who need an account of the subject at an intermediate standard . . . and also as a guide to lecturers."

621.38 2869
Industrial Electronics and Control [Book Review]—R. G. Kloeffler. Publishers: Chapman and Hall, London, 1949, 478 pp., 33s. (*Beama Jour.*, vol. 57, pp. 181–182; June, 1950.) ". . . written not only for the electrical engineer, but also for students of chemical and mechanical engineering who desire a knowledge of industrial electronic applications. The text is descriptive rather than mathematical and the calculus is not employed."

621.38 2870
Electronics, Principles and Applications [Book Review]—R. R. Wright. Publishers: Ronald Press, New York, 1950, 387 pp., $5.50. (*Electronics*, vol. 23, pp. 136, 138; August, 1950.) "A basic course in electronics for non-electrical engineering students."

PROPAGATION OF WAVES

538.566 2871
On the Existence of a Surface Wave in Dipole Radiation over a Plane Earth—T. Kahan and G. Eckart. (PROC. I.R.E., vol. 38, pp. 807–812; July, 1950.) See 2892 of 1949.

621.396.11 2872
Ground-Wave Propagation over an Inhomogeneous Smooth Earth. Part 2—Experimental Evidence and Practical Implications—G. Millington and G. A. Isted. (*Proc. IEE* (London), Part III, vol. 97, pp. 209–217; July, 1950. Discussion, pp. 217–222.) Theoretical considerations of Part 1 (1758 of 1949) are reviewed, which predict an increase in field strength on crossing a land-sea boundary. Further experimental results are discussed and found in agreement with theory, although not conclusive. The best conditions for obtaining such an increase in practice are analysed: a wavelength of 4 m is suitable where the distances involved are small, while 100-m wavelength is preferable where attenuation with distance is much greater over land than over sea. Measurements on these wavelengths of field strength along land-sea paths are described; the results show the predicted increase and fit the calculated curves as well as experimental conditions would allow. Some practical implications of the results are discussed, in particular with regard to the siting of transmitters near water, the possibilities of common-frequency working under ground-wave conditions, and the ground-wave coverage of medium- and long-wave navigation aids.

621.396.11 2873
The Beacon Technique as Applied to Oblique Incidence Ionosphere Propagation—J. T. deBettencourt and H. Klemperer. (PROC. I.R.E., vol. 38, pp. 791–792; July, 1950.) Experiments have been made to identify the propagation paths of pulse signals. An interrogator-responder near Boston transmitted pulses of width 100 μs and repetition rate 20/sec to a transponder in the Caribbean area 2,615 km away. Horizontal rhombic antennas, and transmitters giving 20 kw peak power at 16.08 Mc were used at both stations. Photographic records were obtained showing pulse amplitudes against go-and-return time, and go-and-return time against time of day. One-way transmission time is simply calculated from the observations and the path travelled is then identified by means of available charts.

621.396.11:[551.51:545.326 2874
Determination of Modified Index-of-Refraction over the Gulf of Mexico from Radio Data—Straiton and LaGrone. (*See* 2773.)

621.396.11:551.510.535 2875
Ray Paths of Radio Waves in the Ionosphere—H. Poeverlein. (*Zeit. Angew. Phys.*, vol. 2, pp. 152–160; April, 1950.) Graphs are given of the paths of the ordinary and extraordinary rays for a signal of wavelength 80 m both for vertical and oblique incidence on a linearly ionized and on a parabolically ionized layer at a height of 200–300 km. At vertical incidence the ordinary ray is deflected northwards, the extraordinary ray southwards. For small angles of incidence, ray paths are pointed at their apex and the height of reflection is constant. The ray theory may give inaccurate results near the point of reflection. See also 718 of April.

621.396.11+621.396.81].029.64 2876
Progression of Microwave Radio Scintillations [fluctuations] at Wind Speed on an Overwater Path—A. W. Straiton and H. W. Smith. (PROC. I.R.E., vol. 38, pp. 825–826; July, 1950.) 3.2-cm radio signals transmitted over a 26.5-mile overwater path were recorded by two receivers (*a*) with a horizontal separation of 65 ft. normal to the radio path, (*b*) with a vertical separation of 10 ft. Signal fluctuations progressed at about wind speed between the horizontally separated receivers; a downward but less definite progression was observed for the case of vertical separation. See also 3241 of 1949 and 1483 of July (Straiton et al.).

621.396.81 2877
Propagation of 10-Mc/s Waves over Ranges of 500–1300 km—R. G. Sacasa. (*Rev. Telecomun.* (Madrid), vol. 5, pp. 2–8; December, 1949.) Data for 10 Mc as optimum working frequency are taken from the diagram previously discussed (2614 above); these are rearranged in tabular form and considered in detail. Experimental results for reception during November 1949 of Swiss transmissions on 11.865 and 9.665 Mc are presented.

621.396.81 2878
Propagation of 12-Mc/s and 15-Mc/s Waves over Ranges of 500–2400 km—R. G. Sacasa. (*Rev. Telecomun.* (Madrid), vol. 5, pp. 3–14; March, 1950.) Tabulation and discussion of data obtained from the diagram previously given (2614 of December). Experimental results for 15.17-Mc transmissions from Oslo during the period October 1949–February 1950 are presented. Agreement with prediction is very satisfactory.

621.396.812.029.64 2879
Microwave Attenuation Statistics Estimated from Rainfall and Water Vapor Statistics—H. E. Bussey. (PROC. I.R.E., vol. 38, pp. 781–785; July, 1950.) Curves are derived giving predictions of the number of hours per year during which the overall attenuation of a 50-km path and a 1-km path at Washington will exceed various values, for frequencies above 1 kMc. The results are obtained by analyzing available meteorological data, theoretically derived factors (515 of 1947) being used for converting into radio attenuation values. Extension of the method to other parts of the U.S.A. is discussed.

RECEPTION

621.396.621:621.396.619.13 2880
Detector Circuits for Frequency-Modulation Receivers—C. J. Boers. (*Fernmeldetech. Z.*, vol. 3, pp. 296–300; August, 1950.) The disturbing effects of undesired am are examined, and the action of limiters is explained. A subsequent paper is to deal with particular types of discriminator circuit.

621.396.621:621.396.619.13:621.396.931 2881
Mobile F.M. Broadcast Reception—R. C. Barritt. (*Electronics*, vol. 23, pp. 74–78; August, 1950.) A report of results obtained with various types of antenna and circuit for fm broadcast reception in moving vehicles. Increased sensitivity and improved limiting circuits appear to be necessary.

621.396.621:621.396.822 2882
Analysis of the Signal/Noise Ratio in U.H.F. Receivers—E. W. Herold. (*Rev. Telecomun.* (Madrid), vol. 5, pp. 47–60; March, 1950.) A translation from "Radio at Ultra-High Frequencies," vol. 2, published by RCA Review. See 2336 of 1942.

621.396.622.015.7†:621.396.822 2883
Detection of a Pulse Superimposed on Fluctuation Noise—B. M. Dwork. (PROC. I.R.E., vol. 38, pp. 771–774; July, 1950.) The frequency response of a linear device giving the maximum value for the ratio between peak amplitude of the signal and the rms value of the noise at the output is determined analytically for a known pulse superimposed on fluctuation noise with a known spectrum. The result is applied to the case in which the fluctuation noise has a uniform frequency distribution; the optimum network is then physically realizable if the pulse differs from zero for only a finite interval of time. The noise-suppression efficiency of a conventional RC circuit is computed for rectangular and for exponentially decaying pulses.

621.396.662:[621.396.619.13+621.397.62 2884
A New TV-FM Tuner—C. W. Lytle. (*Tele-Tech*, vol. 9, pp. 21–23, 86; June, 1950.) Detailed description of a continuously variable inductive tuner in which tuning is effected by a rotor carrying copper vanes serving as short-circuited turns when brought near the inductor coils. Two sets of coils and vanes are used, one set for the high and the other for the low US television band.

621.396.662.085.3 2885
Hypersensitive Resonance Indicator—R. L. Ives. (*Electronics*, vol. 23, pp. 118–154; August, 1950.) Application of Foster-Seeley and Doppelganger discriminators to resonance indication for weak and fading signals is discussed. Circuit details are given of a complete unit that can be added to any standard superheterodyne receiver.

621.396.81 2886
Propagation of 10-Mc/s Waves over Ranges of 500–1300 km—Sacasa. (*See* 2877.)

621.396.81 2887
Propagation of 12-Mc/s and 15-Mc/s Waves over Ranges of 500-2400 km—Sacasa. (*See* 2878.)

STATIONS AND COMMUNICATION SYSTEMS

621.39.001.11 2888
Statistical Theory of Communication—J. B. Wiesnet. (*Proc. NEC* (Chicago), vol. 5, pp. 334–341; 1949.) Difficulties in the analysis of communication systems are pointed out and the statistical methods developed by Wiener and Shannon are outlined. The use of statistical concepts to provide a new kind of filtering in the time domain is described. See also 2465 above (Wiener) and 1649 of 1949 (Shannon).

621.394/.395].44 2889
Carrier-Frequency Technique in Germany, 1935–1945—G. Hässler. (*Elektrotechnik*, Berlin, vol. 2, pp. 161–168; June, 1948.)

621.395:621.318.572 2890
Voice-Switched Intercom—R. H. Baer. (*Electronics*, vol. 23, pp. 79–81; August, 1950.) Instead of a talk-listen switch this system uses a 4-terminal repeater with a flip-flop circuit that unblocks gated amplifiers alternately 30 times per sec. Incoming speech signals stop the flip-flop and keep open the desired channel without clipping syllables.

621.395.44 2891
A Twelve-Channel Carrier Telephone System for Use on Cables—T. B. D. Terroni. (*Strowger Jour.*, vol. 7, pp. 62–81; July, 1950.) The principal factors which determine the design of 12-channel systems are outlined and the single-modulation method using crystal filters and the group-modulation method using inductor-capacitor filters are discussed. The special features of a group-modulation system are described and performance details are given.

621.396.1:519.242 2892
An Extension of Wiener's Theory of Prediction—Zadeh and Ragazzini. (*See* 2808.)

621.396.3+621.396.5](43) 2893
Survey of the [German] Overseas Radio Service—W. Kronjäger. (*Fernmeldetech. Z.*, vol. 3, pp. 265–271; August, 1950.) The different telephony and telegraphy systems are indicated and the organization of the corresponding services is described. Traffic figures are given for 1949.

621.396.61/.62(621.396.931 2894
Mobile Radio Unit—D. Samuelson. (*FM–TV*, vol. 10, pp. 18–19, 33; July, 1950.) Design details, with illustrations, of a small transmitter-receiver capable of operating in a single channel without picking up adjacent-channel signals or causing interference with other systems. Transmitter power output is 12 w on 25–50 Mc and 10 w on 151–174 Mc.

621.396.65:621.396.619.11/.13 2895
Modulation Conversion in a Wave Guide—P. S. Rogell. (*Jour. Appl. Phys.*, vol. 21, pp. 629–631; July, 1950.) Theory and design equations are presented for the conversion of a narrow-band FM microwave signal into an almost pure AM signal within a waveguide of given dimensions. Frequency relations and guide dimensions are arranged so that the FM sidebands are shifted with respect to the carrier until they become AM sidebands at the guide output. A complex intelligence signal may be transmitted with negligible distortion if it is used for AM of an intermediate carrier which is then applied for FM of the microwave carrier.

621.396.65.029.63/.64:621.397.5 2896
2000- and 7000-Mc/s TV Microwave Relays—E. D. Hilburn. (*TV Eng.*, vol. 1, pp. 8–11; 18–21; 16, 35; 26; March-June, 1950.) Relay equipment for transmission of outside programs to station WMAL-TV is described. The 7-kMc equipment is portable and serves for local transmissions over line-of-sight paths up to about 20 miles, while the more powerful 2-kMc equipment is used between fixed stations and is effective at much greater ranges. Installation and operation procedures are discussed.

621.396.7+621.397.7](73)(058.7) 2897
Tele-Tech TV-FM-AM Station & Studio Equipment Directory, 1951—(*Tele-Tech*, vol. 9, pp. 37–39, 84; June, 1950.) A very comprehensive list of U. S. stations of all types, and of manufacturers of equipment directly or indirectly connected with radio and television.

621.396.712.029.6:621.396.619.13(43) 2898
The Technique of U.S.W. Broadcasting—L. Rohde. (*Fernmeldetech. Z.*, vol. 3, pp. 286–292; August, 1950.) Germany is the first European country to introduce ultra-short wave FM broadcasting. American practice has been studied and full advantage is taken of the possibilities of FM, viz., high quality, economic use of frequency channels and reduced interference. Radio links are preferred to cable for all but very short distances. Tetrodes are used for power up to 1 kw, triodes for higher power. The advantages of small automatically controlled transmitters are pointed out, and filter arrangements are described which permit two programs to be radiated from the same antenna.

621.396.712(43) 2899
Basis of U.S.W. Plan for the U. S. Zone [of Germany]—F. Gutzmann. (*Fernmeldetech. Z.*, vol. 3, pp. 276–278; August, 1950.)

621.396.712(43) 2900
The U.S.W. Network of the North-West Germany Broadcasting System—W. Nestel. (*Fernmeldetech. Z.*, vol. 3, pp. 282–285; August, 1950.)

621.396.712(43) 2901
The U.S.W. Network of the South-West [Germany] Broadcasting System—Knöpfel. (*Fernmeldetech. Z.*, vol. 3, pp. 279–281; August, 1950.)

SUBSIDIARY APPARATUS

621.526 2902
A Note on the Error Coefficients of a Servo Mechanism—J. L. Bower. (*Jour. Appl. Phys.*, vol. 21, p. 723; July, 1950.)

621.316.722.1:621.316.261 2903
A Preservation Rectifier with Electronically Stabilized Charging Voltage—E. Cassee. (*Philips Tech. Rev.*, vol. 11, pp. 253–259; March, 1950.) The difference between the charging voltage of an accumulator battery and a constant reference voltage is amplified and used to control the dc bias of a transductor in series with the secondary of the transformer feeding the rectifier in the charging equipment. The charging voltage is thereby maintained constant to within 0.5 per cent for mains frequency deviations of 4 per cent or voltage variations of 10 per cent.

621.355.2+621.355.8 2904
Military Storage Batteries—H. Mandel. (*Elec. Eng.*, vol. 69, pp. 619–621; July, 1950.) Recent developments are described, particularly as regards lead-acid batteries and alkaline batteries with sintered Ni-Cd plates, and obtaining satisfactory performance at very low temperatures.

TELEVISION AND PHOTOTELEGRAPHY

621.397.5:621.317.799† 2905
Inexpensive Picture Generator—Popkin-Clurman. (*See* 2842.)

621.397.5:621.396.65 2906
Televising the Boat Race—1950: The Engineering Problems—T. H. Bridgewater, R. H. Hammans, and S. N. Watson. (*BBC Quart.*, vol. 5, pp. 107–115; Summer, 1950.) A detailed account of the system of radio and cable links connecting the equipment on the launch following the race with the Alexandra Palace transmitter.

621.397.5:621.396.65.029.63/.64 2907
2000- and 7000-Mc/s TV Microwave Relays—Hilburn. (*See* 2896.)

621.397.5(43) 2908
The Development of Television by the German Post Office—H. Pressler. (*Fernmeldetech. Z.*, vol. 3, pp. 302–308; August, 1950.) A historical review, with extensive bibliography.

621.397.5(43) 2909
Development of Television Technique by the Fernseh G.m.b.H. 1939–1945—H. Bähring, W. Dillenburger, R. v. Felgel-Farnholz, T. Mulert, F. Rudert, and H. Strübig. (*Fernmeldetech. Z.*, vol. 3, pp. 308–316; August,

1950.) A review of the most important advances made during the period when normal publication was suspended.

621.397.6 2910
A Film Dubbing and Review Suite for Television Film Production—N. F. Chapman. (*BBC Quart.*, vol. 5, pp. 116–128; Summer, 1950.) Detailed account of facilities noted in 1539 of July.

621.397.61:621.396.619.2 2911
An Analysis of Single and Double Sideband Transmission—G. E. Hamilton and R. G. Artman. (*TV Eng.*, vol. 1, pp. 22–24; July, 1950.) A mathematical analysis of double sideband and single-sideband transmission. The attenuation may vary between 6 db and 7 db according to the modulation factor. In double-sideband operation the detector need respond only to the modulating frequencies, but for single-sideband transmission a detector with infinite bandwidth is needed to give faithful reproduction.

621.397.61:621.396.645.018.424:621.3.088.7 2912
The Compensation for Phase Errors in Wide-Band Video Amplifiers—Brain. (*See* 2752.)

621.397.61:621.396.673 2913
1 057-Foot FM-TV Antenna—(*See* 2722.)

621.397.611.2 2914
A New Image Orthicon—R. B. Janes, R. E. Johnson, and R. R. Handel. (*Proc. NEC* (Chicago), vol. 5, pp. 140–147; 1949.) The spectral sensitivity characteristics of image orthicons are discussed and the properties of a new panchromatic high-sensitivity photosurface used in the RCA Type 5820 orthicon are described. This makes television possible under poor lighting conditions. Production problems for the Type 5820 orthicon are briefly discussed. See also 2361 of October.

621.397.621.2:621.385.832 2915
The Design and Fabrication of TV Picture Tubes—Hoagland. (*See* 1943.)

621.397.62:621.314.2 2916
A Universal-Application Cathode-Ray Sweep Transformer with Ceramic Iron Core—C. E. Torsch. (*Proc. NEC* (Chicago), vol. 5, pp. 130–139; 1949.) The high-μ high-Q ceramic-iron cores now available enable cathode-ray tube sweep transformers of high efficiency to be produced. The design of a unit which can be used with any direct-view picture tube is described and typical circuits for use with the unit are given.

621.397.62+621.396.619.13]:621.396.662 2917
A New TV-FM Tuner—Lytle. (*See* 2884.)

621.397.62:621.396.662 2918
Two New Television Tuners—M. F. Melvin. (*Proc. NEC* (Chicago), vol. 5, pp. 148–160; 1949.) Description and performance details of 3-section and 4-section "spiral" inductuners which are both cheaper and mechanically simpler than previous solenoid designs.

621.397.62:621.396.67 2919
An Automatic Built-In Antenna for Television Receivers—K. Schlesinger. (*Proc. NEC* (Chicago), vol. 5, pp. 292–302; 1949.) See 819 of May.

621.397.82 2920
Interference Patterns in Television Pictures—(*Jour. Telev. Soc.*, vol. 6, pp. 22–23; January-March, 1950.) Photographs taken by the GPO officials are shown, illustrating the disturbing effects produced on television pictures by different types of interference.

621.397.5 2921
Television Simplified [Book Review]—M. S. Kiver. Publishers: D. Van Nostrand Co., New York, 3rd edn 1950, 556 pp., $6.50. (Proc. I.R.E., vol. 38, p. 832; July, 1950.) The basic principles of television are explained for the nonmathematical reader. The book deals almost entirely with receivers, and includes a chapter on servicing and installation. New chapters cover intercarrier television sound and color television.

TRANSMISSION

621.396.61 2922
Lorenz 10-kW U.S.W. Transmitter for F.M. Broadcasting—G. Brauer. (*Fernmeldetech. Z.*, vol. 3, pp. 292–296; August, 1950.) Two of these transmitters have been in operation in Germany since early 1950. An explanation is given of the differences of design called for at frequencies of 87.5–100 Mc as compared with transmitters for lower frequencies. The grounded-grid triode power-amplifier tube is described in some detail.

621.396.61:621.396.619.13 2923
3000 Watts for State Police—W. Fingerle, Jr. (*FM-TV*, vol. 10, pp. 11–12, 33; July, 1950.) Illustrated description of a FM transmitter operating in the range 40–50 Mc. Tests indicate that such transmitters give effective state coverage.

621.396.611.21.029.63:621.396.931 2924
Crystal Control for Citizens Band—I. Gottlieb and I. R. Mednick. (*Electronics*, vol. 23, pp. 96–98; August, 1950.) Stabilized operation of a war-surplus BC-645 unit on 460 Mc is effected by the addition of a 2-tube exciter unit and by use of the Type 316-A tube in the BC-645 as a frequency doubler. Frequencies in the band 460–470 Mc are derived from crystals with fundamental frequencies between 8.52 Mc and 8.70 Mc. See also 517 of 1949 (Samuelson).

621.396.619.13 2925
A Versatile Crystal Controlled Source of Angle Modulation—J. F. Gordon. (*Proc. NEC* (Chicago), vol. 5, pp. 512–518; 1949.) A device is described which produces large deviations and increased modulation sensitivity without loss of transmitter stability; the relatively small number of tubes used results in a simple circuit. An experimental unit and details of its performance are also described.

TUBES AND THERMIONICS

621.314.632 2926
G.E.C. Germanium Crystal Rectifiers—(*Instr. Practice*, vol. 4, pp. 427–428; June, 1950.) Characteristics of four available types are tabulated. All are sealed in glass envelopes and have the metal point cemented to the Ge crystal.

621.314.671 2927
A New Rectifier Tube for Extremely High Power and Voltage Levels—T. H. Rogers. (*Proc. NEC* (Chicago), vol. 5, pp. 482–492; 1949.) The factors which control the design of high-vacuum rectifiers and limit their use for high-current applications are discussed, and new design principles are outlined which have been evolved to raise these limits sufficiently to meet the requirements of devices using high-current high-voltage supplies. New tubes described can handle a peak current of 10 a and an inverse voltage of 110 kv.

621.383 2928
Design Features and Some Applications of a New Photocell—J. H. Crow and V. C. Rideout. (*Proc. NEC* (Chicago), vol. 5, pp. 506–511; 1949.) See 1288 of June.

621.383.27† 2929
Photocells with Secondary-Electron Multipliers—N. Schaetti. (*Helv. Phys. Acta*, vol. 23, pp. 108–120; February, 3, 1950. In German.) The production and properties of various photocathodes and secondary-emission layers is discussed. An 18-stage multiplier with an Ab-Cs photocathode and Ag-Mg coating for the multiplier plates has a sensitivity of 40–60 μa/lumen and a total amplification of $10^{10}-10^{12}$ with a stage voltage of 200 v.

621.383.4 2930
The Phototransistor—J. N. Shive. (*Bell Lab. Rec.*, vol. 28, pp. 337–342; August, 1950.) The essential element in the device is a wafer of Ge with a spherical dimple ground in one face so that at the centre, where a phosphor-bronze wire 0.005 in. diameter makes contact, the thickness is about 0.003 in. Operation of the cell depends on the decrease in resistance of the Ge element between its containing ring and the collector wire on exposure to light. For a particular cell operated in series with a 20-k Ω resistor, the calculated current output was about 0.07 ma per millilumen. With fluctuating light the response curve is substantially flat up to 200 kc, the highest frequency so far used. The sensitivity is greatest in the spectral region 1.0–1.5 μ. An outline of the theory of the mechanism of photoconductivity is given.

621.385:621.396.621 2931
The 6BN6 Gated Beam Tube—R. Adler. (*Proc. NEC* (Chicago), vol. 5, pp. 408–416; 1949.) See 1292 of June.

621.385:621.396.621 2932
The 6BN6 Gated Beam Tube—A. P. Haase. (*Proc. NEC* (Chicago), vol. 5, pp. 417–426; 1949.) See 1292 of June (Adler).

621.385–712 2933
New Type of Radiator for High-Power Transmitting Tubes—C. Schärli. (*Brown Boveri Rev.*, vol. 36, pp. 311–315; September, 1949.) A radiator system is described which uses transverse fins consisting of sheet-metal rings separated by spacers and riveted together. Applied to the Type-ATL 35–1 tube it can handle an anode dissipation of 46 kw.

621.385.032.216 2934
Conduction Processes in the Oxide-Coated Cathode—R. Loosjes and H. J. Vink. (*Philips Tech. Rev.*, vol. 11, pp. 271–278; March, 1950.) Preparation and activation of oxide-coated cathodes is described. Electrons emitted by the coating are replaced by conduction from the metal core and it is suggested that this conduction is due to two processes acting together, electronic conduction of the grains at temperatures $<800°K$ and conduction through the electron gas in the pores between the grains at higher temperatures. The lagging of conduction behind emission at temperatures $>1,000°K$ is explained by the effect of the space charge upon the electron density and upon the field in the pores.

621.385.032.24:537.58 2935
Experiments on Grid Emission—A. A. Rusterholz. (*Brown Boveri Rev.*, vol. 36, pp. 300–304; September, 1949.) Methods are discussed which result in reduced primary grid emission, particularly in transmitting tubes with thoriated-tungsten cathodes. Carburization of the Ta grid wires at a high temperature in CO or CO_2 has been suggested as a means of preventing an increase of grid emission due to activation by Th evaporated from the filament. Experiments with grids carburized in an atmosphere of H_2 saturated with benzene vapor showed, however, that no improvement was effected. Investigations of carburization in CO or CO_2 are being continued.

621.385.032.442:621.3.025.4 2936

Hum Characteristics of A.C.-Heated Transmitting Tubes—E. Atti. (*Brown Boveri Rev.*, vol. 36, pp. 305–311; September, 1949.) The hum level in transmitting tubes with directly heated tungsten filaments can be reduced very considerably by use of specially designed cathode systems and 3-phase or 6-phase heater supplies. Careful balancing of the phases and accurate alignment of the grid and the filament wires is essential. In the new 200-kw broadcasting transmitter at Beromünster, the hum level in the alternating-frequency output stage, which consists of two class-B triodes with 3-phase heating, is −57db without feedback, which lowers it further to −61db.

621.385.2 2937

The High-Frequency Response of Cylindrical Diodes—E. H. Gamble. (*Proc. NEC* (Chicago), vol. 5, pp. 387–402; 1949.) The problem is considered as a quasistationary one and equations are derived for an ideal diode in which the electron paths are normal to the emitting surface. The relations thus obtained are applied to space-charge-limited and temperature-limited operation. Numerical solutions of the nonlinear integral equations were obtained from analogue-computer solutions for the corresponding differential equations. The results indicate the essential correctness of the treatment of the problem.

621.385.3:621.315.592†]:621.396.822 2938

Low-Frequency Noise in Transistors—H. T. Mooers. (*Proc. NEC* (Chicago), vol. 5, pp. 17–22; 1949.) The alternating-frequency spectra of both emitter and collector noise in six type-A transistors were investigated. Noise output varies with frequency, but not inversely. Emitter noise does not contribute significantly to the noise output, and this output is independent of dc voltage, current and resistance. Good correlation is found between noise power and forward transfer impedance. The noise output may be predicted fairly accurately at any given operating point, for any bandwidth up to 15 kc. The lowest input signal strength required to produce a given output signal-noise ratio can also be estimated.

621.385.4:621.319.43 2939

Variable-Capacitance Tube for Frequency Control—R. W. Slinkman. (*Sylvania Technologist*, vol. 3, pp. 18–20; July, 1950.) Frequency stabilization of very-high-frequency and ultra-high-frequency oscillators in FM receivers is effected by means of a tetrode with a bimetallic anode. The curvature of the anode varies with changes of frequency and affects the value of a capacitor within the tube which forms part of the oscillator tank circuit. External series capacitors enable the effective control bandwidth to be adjusted. Tests in a commercial FM receiver and in an experimental 600-Mc television converter have given promising results.

621.385.832 2940

Beam Deflection Nonlinear Element—A. A. Soltes. (*Electronics*, vol. 23, pp. 122–178; August, 1950.) A parabolic mask placed between deflector plates and collector enabled a square-law static characteristic to be obtained with an electron beam of rectangular cross-section. Instantaneous squaring of radar-type signals to an accuracy of 2 per cent of full-scale, at an input frequency to the deflector plates of 40 Mc, was achieved by this means in the Raytheon tube Type QK-256.

621.385.832 2941

Dimensional Tolerances in Cathode-Ray-Tube Guns—H. Moss, L. Woodbridge, and M. Webb. (*Proc. IEE* (London), Part III, vol. 97, pp. 277–283; July, 1950.) Preliminary experiments show that cathode tilt in the triode has negligible effect on beam centrality and symmetry. Effects of lateral displacement and tilt of the first anode for various grid-anode spacings are determined experimentally for several types of triode geometry. The astigmatism due to the tilt, displacement and deformation of the final lens elements is also investigated experimentally and an effective type of ion-trap electron gun is described.

621.385.832:621.3.087 2942

The Recording Storage Tube—R. C. Hergenrother and B. C. Gardner. (Proc. I.R.E., vol. 38, pp. 740–747; July, 1950.) A cathode-ray tube has a mesh screen coated on the face away from the electron gun with a charge-retaining layer. The potential of an output-signal screen located further along the tube is made negative relative to the cathode, so that when the signal is applied "written" the beam passes through the mesh screen and is reflected to strike its rear (storage) surface, whereas when the signal is taken off "read" the beam strikes the output-signal screen, which in this case is made more positive than the storage-screen mesh potential, and does not disturb the stored charges. The signal can thus be read 20,000 times without appreciable deterioration and with a decrease in signal level of only a few per cent.

621.385.832:621.397.611.2 2943

The Design and Fabrication of TV Picture Tubes—K. A. Hoagland. (*TV Eng.*, vol. 1, pp. 16–21, 35 and 16–17; March and April, 1950.) A survey of American manufacturing processes and discussion of present trends in cathode-ray tube design, with particular attention to beam focusing the use of slant-field and bent-gun ion traps, metal-cone construction etc.

621.396.615.14:621.385.029.63/.64 2944

The Helix as Resonator for Generating Ultra High Frequencies—B. B. van Iperen. (*Philips Tech. Rev.*, vol. 11, pp. 221–231; February, 1950.) The action of the travelling-wave tube as an amplifier is described briefly and its use as an ultra-high-frequency generator is discussed. The resonances of the helix play an important part in this latter case. A relatively simple method is developed for determining under what conditions oscillations are possible and at what current intensity they begin. Results are given of some experiments which confirm the accuracy of the theory. An experimental tube with gas-concentrated beam is described.

621.396.615.141.2 2945

The Turbator—F. Lüdi. (*Brown Boveri Rev.*, vol. 36, pp. 315–318; September, 1949.) The evolution is reviewed of the Brown Boveri type of magnetron, which comprises a Ba-Sr oxide cathode and a single annular cavity resonator capacitively coupled to the anode segments. The Mo sheet-metal construction of the anode enables an anode dissipation of 200 w to be attained. A glass-enclosed 15-w type is being developed.

621.396.615.141.2:621.317.361 2946

Measurement of the Space-Charge Resonance Frequencies in a Multicavity Magnetron—P. Fechner. (*Compt. Rend. Acad. Sci.*, (Paris), vol. 231, pp. 270–271; July 24, 1950.) The magnetron is coupled to a waveguide which is terminated by its characteristic impedance and energized by a klystron generator. Resonance conditions are determined from measurements of the transmission coefficient in the waveguide for different values of magnetic field and anode voltage. The results obtained verify the theory previously given (2678 of December). See also 2680 of December.

621.396.615.142 2947

Radial-Beams Velocity-Modulated Microwave Tube.—C. G. Lob and D. F. Holshouser. (*Proc. NEC* (Chicago), vol. 5, pp. 403–407; 1949.) The tube consists of a coaxial resonator of length $\lambda/2$, cut in the middle perpendicular to its axis of symmetry so as to constitute two coaxial cavities, each operating in the $\lambda/4$ mode. Surrounding the cut in the resonator is a gun structure with a ring cathode and two focusing electrodes. The action of the tube is similar to that of a two-gap klystron or of a reflex klystron, depending on the operating conditions. Test results on three experimental tubes are given. An output of about 3 mw was obtained at a wavelength of 4 cm.

621.396.615.142.2 2948

Efficiency of Reflex Oscillators—W. G. Sheperd. (*Proc. NEC* (Chicago), vol. 5, pp. 500–505; 1949.) Analysis of the efficiency and electronic tuning of a reflex oscillator as affected by the use of different modulation coefficients for the outgoing and return transits of the interaction gap.

621.396.645:621.396.822 2949

Noise Suppression in Triode Amplifiers—van der Ziel (*See* 2751.)

MISCELLANEOUS

621.396.7+621.397.7](73)(058.7)
621.396.6.65(73)(058.7) 2950

Tele-Tech TV-FM-AM Station & Studio Equipment Directory, 1951—(*See* 2897.)

658.562:519.283 2951

The Theory of Sampling Inspection Plans—H. C. Hamaker. (*Philips Tech. Rev.*, vol. 11, pp. 260–270; March, 1950.) Mathematical principles underlying sampling inspection are discussed. Two parameters for describing an operating characteristic, termed "point of control" and "relative slope," are introduced and their relation to sample size and acceptance number is established. Various other parameters in use are reviewed and reasons are given for the choice of the point of control and sample size as a practical set.

621.3 2952

Basic Electrical Engineering [Book Review]—G. F. Corcoran. Publishers: Chapman & Hall, London, 1949, 449 pp. 27s. (*Beama Jour.*, June, 1950. vol. 57, p. 179.) "... the treatment ... is clear, smoothly sequential, succinct but without undue condensation ... It is a most commendable piece of work."

621.396 2953

Radio Handbook [Book Review]—R. L. Dawley, (Ed.). Publishers: Editors and Engineers, Santa Barbara, California, 12th edn. 1949, 320 pp., $3.25. (*Electronics*, vol. 23, pp. 142, 144; August, 1950.) An all-construction edition dealing with transmitter and receiver equipment, including mobile sets. "This edition does not supersede the 11th edition [2680 of 1948], which contains different information and remains current."

621.396/.397 2954

Outline of Radio, Television and Radar [Book Review]—R. S. Eleven, T. J. Fielding, E. Molloy, H. E. Penrose, C. A. Quarrington, M. G. Say, R. C. Walker, and G. Windred. Publishers: Chemical Publ. Co., Brooklyn, 1950, 688 pp., $12.00. (*Electronics*, vol. 23, p. 142; August, 1950.) A book compiled by eight British engineers. "Extensive use of British terminology throughout, along with descriptions and illustrations of British products ... does not impair the usefulness of the book to those seeking to keep in touch with British practice."

Back Copies

The Institute endeavors to keep on hand a supply of back copies of the PROCEEDINGS for sale for the convenience of those who do not have complete files. However, some issues are out of print and cannot be provided.

All available back issues of the PROCEEDINGS OF THE I.R.E. are priced at $2.25 per copy to individual nonmembers; $1.65 per copy to public libraries, colleges, and subscription agencies; and $1.00 per copy to Institute members. Price includes postage in the United States and Canada; postage to other countries is ten cents per copy additional.

1913–1915 Volumes 1–3 Quarterly

1913 Vol. 1 January (a reprint)

1916–1926 Volumes 4–14 Bimonthly

1917	Vol. 5	December	1923	Vol. 11	February, April, October, December
1920	Vol. 8	April, June, August, October, December	1924	Vol. 12	August, October
1921	Vol. 9	February, April, June, August, October, December	1925	Vol. 13	April, June, August, October, December
1922	Vol. 10	All 6 issues	1926	Vol. 14	All 6 issues

1927–1938 Volumes 15–26 Monthly

1927	Vol. 15	April, May, June, July, October, December	1933	Vol. 21	All 12 issues
1928	Vol. 16	February to December, inc.	1934	Vol. 22	All 12 issues
1929	Vol. 17	April, May, June, November, December	1935	Vol. 23	All 12 issues
1930	Vol. 18	April to December, inc.	1936	Vol. 24	January, February, March
1931	Vol. 19	All 12 issues	1937	Vol. 25	February to December, inc.
1932	Vol. 20	January, March to December, inc.	1938	Vol. 26	All 12 issues

1939–1950 Volumes 27–38 Monthly

New Format—Large Size

1939	Vol. 27	January, February, March, May, December	1945	Vol. 33	January to July, inc., September to December, inc.,
1940	Vol. 28	All 12 issues	1946	Vol. 34	January, February, April to December, inc.
1941	Vol. 29	All 12 issues	1947	Vol. 35	January to May, inc., July, October to December, inc.
1942	Vol. 30	January to May, October to December, inc.			
1943	Vol. 31	February to December, inc.	1948	Vol. 36	All 12 issues
1944	Vol. 32	January, February, April, May, August to December, inc.	1949	Vol. 37	January to April, inc., July to December, inc.
			1950	Vol. 38	All 12 issues

Cumulative Indexes covering the periods 1913–1942 and 1943–1947 are available at the same prices as back issues of PROCEEDINGS.

Proceedings Binders

Sturdy binders of blue Spanish-grain fabricoid with gold lettering, which will serve either as temporary transfers or as permanent holders for the PROCEEDINGS may be obtained in the large size only (1939 to date) at the following prices: $2.50 for plain; $3.00 for Vol. No. or year, or your name imprinted; $3.50 for Vol. No. and name or name and year imprinted. Postage is prepaid in United States or Canada; postage to other countries, 50 cents additional.

Membership Emblems

The IRE emblem is available to members in three useful forms; the lapel button, the pin, and the watch charm. Each is of 14-karat gold, enameled in color to designate the grade of membership.

Grade	Background Color
Fellow	Gold
Senior Member	Dark Blue
Member	Light Blue
Associate	Maroon
Student	Green

The lapel button has a screw back with jaws which grip the cloth of the coat. These are priced at $3.00 each. The pin, at $3.50 each, is provided with a safety catch. The watch charm, enameled on both sides and equipped with a suspension ring for attaching to a watch charm or fob, is $5.50.

Prices on emblems are the same for all grades of membership and include Federal tax, postage, and insurance or registered-mail fee.

Remittance should accompany your order.

Please do not send cash except by registered mail.

THE INSTITUTE OF RADIO ENGINEERS, INC.

1 East 79 Street, New York 21, New York

Current IRE Standards

In addition to the technical papers published in the PROCEEDINGS OF THE I.R.E., Standards on various subjects have been printed. These are available at the prices listed below. A 20% discount will be allowed on orders for 100 or more copies mailed to one address.

	Price
48 IRE 2, 11, 15 S1 Standards on Antennas, Modulation Systems, and Transmitters: Definitions of Terms, 1948. (vi+25 pages, 8½×11 inches)	$0.75
48 IRE 2 S2 Standards on Antennas: Methods of Testing, 1948. (Adopted by ASA C16.11-1949). (vi+18 pages, 8½×11 inches)	$0.75
42 IRE 3 S1 American Recommended Practice for Volume Measurements of Electrical Speech and Program Waves. (Adopted by ASA C16.5-1942). (8 pages, 7¾×10⅝ inches)	$0.20
42 IRE 6 S1 American Recommended Practice for Loudspeaker Testing. (Adopted by ASA C16.4-1942). (12 pages, 7¾×10⅝ inches)	$0.25
38 IRE 6 S1 Standards on Electroacoustics, 1938. Definitions of Terms, Letter and Graphical Symbols, Methods of Testing Loud Speakers. (vi+37 pages, 6×9 inches)	$0.50
50 IRE 7 S1 Standards on Electron Tubes: Definitions of Terms, 1950. Reprinted from the April, 1950, PROCEEDINGS (pp. 426–438)	$0.75
50 IRE 7 S2 Standards on Electron Tubes: Methods of Testing, 1950. Part I reprinted from August, 1950, PROCEEDINGS (pp. 917–948); Part II reprinted from September, 1950, PROCEEDINGS (pp. 1079–1093)	$1.25
42 IRE 9 S1 Standards on Facsimile: Definitions of Terms, 1942. (vi+6 pages, 8½×11 inches)	$0.20
43 IRE 9 S1 Standards on Facsimile: Temporary Test Standards, 1943. (iv+8 pages, 8½×11 inches)	$0.20
49 IRE 12 S1 Standards on Radio Aids to Navigation: Definitions of Terms, 1949. Reprinted from the December, 1949, PROCEEDINGS (pp. 1364–1371)	$0.60
45 IRE 14 S1 Standards on Piezoelectric Crystals: Recommended Terminology, 1945. (iv+4 pages, 8½×11 inches)	$0.20
49 IRE 14 S1 Standards on Piezoelectric Crystals, 1949. Reprinted from the December, 1949, PROCEEDINGS (pp. 1378–1395)	$0.80
49 IRE 16 S1 Standards on Railroad and Vehicular Communications: Methods of Testing, 1949. Reprinted from the December, 1949, PROCEEDINGS (pp. 1372–1375)	$0.50
38 IRE 17 S1 Standards on Radio Receivers: Definitions of Terms, 1938. A Reprint (1942) of the like-named section of "Standards on Radio Receivers, 1938." (vi+6 pages, 8½×11 inches)	$1.00
47 IRE 17 S1 Standards on Radio Receivers: Methods of Testing Frequency-Modulation Broadcast Receivers, 1947. (Adopted by ASA C16.12-1949). (vi+15 pages, 8½×11 inches)	$0.50
48 IRE 17 S1 Standards on Radio Receivers: Methods of Testing Amplitude-Modulation Broadcast Receivers, 1948. (vi+24 pages, 8½×11 inches)	$1.00
49 IRE 17 S1 Tests for Effects of Mistuning and for Downward Modulation. 1949 Supplement to 47 IRE 17 S1. Reprinted from the December, 1949, PROCEEDINGS (pp. 1376–1377)	$0.25
48 IRE 22 S1 Standards on Television: Methods of Testing Television Receivers, 1948. (Adopted by ASA C16.13-1949). (vi+32 pages, 8½×11 inches)	$1.00
48 IRE 21 S1 Standards on Abbreviations, Graphical Symbols, Letter Symbols, and Mathematical Signs, 1948. (vi+21 pages, 8½×11 inches)	$0.75
49 IRE 21 S1 Standards on Designations for Electrical, Electronic and Mechanical Parts and their Symbols, 1949. Reprinted from February, 1950, PROCEEDINGS (pp. 118–124)	$0.60
47 IRE 22 S1 Standards on Television: Methods of Testing Television Transmitters, 1947. (vi+18 pages, 8½×11 inches)	$0.75
48 IRE 22 S2 Standards on Television: Definitions of Terms, 1948. (iv+4 pages, 8½×11 inches)	$0.50
50 IRE 23 S1 Standards on Television: Methods of Measurement of Television Signal Levels, Resolution, and Timing of Video Switching Systems, 1950. Reprinted from the May, 1950, PROCEEDINGS (pp. 551–561)	$0.70
50 IRE 23 S2 Standards on Television: Methods of Measurement of Time of Rise, Pulse Width, and Pulse Timing of Video Pulses in Television, 1950. Reprinted from the November, 1950, PROCEEDINGS (pp. 1258–1263)	$0.75
50 IRE 24 S1 Standards on Wave Propagation: Definitions of Terms, 1950. Reprinted from the November, 1950, PROCEEDINGS (pp. 1264–1268)	$0.60
42 IRE 24 S2 Standards on Radio Wave Propagation: Measuring Methods, 1942. Methods of Measuring Radio Field Intensity, Methods of Measuring Power Radiated from an Antenna, Methods of Measuring Noise Field Intensity. (vi+16 pages, 8½×11 inches)	$0.50
45 IRE 24 S1 Standards on Radio Wave Propagation: Definitions of Terms Relating to Guided Waves, 1945. (iv+4 pages, 8½×11 inches)	$0.20
Normas Sobre Receptors de Radio, 1938.* A Spanish-language translation of "Standards on Radio Receivers, 1938," by the Buenos Aires Section of The Institute of Radio Engineers. (vii+64 pages, 6×9 inches)	**Two Argentine Pesos (Postpaid)**

* Not carried in stock at IRE Headquarters in New York. Obtainable only from Senor Domingo Arbo, Editor of *Revista Telegrafica*, Peru, 165, Buenos Aires, Argentina.

PRICES ARE NET AND INCLUDE POSTAGE TO ANY COUNTRY.

INCLUDE REMITTANCE WITH ORDER AND ADDRESS.

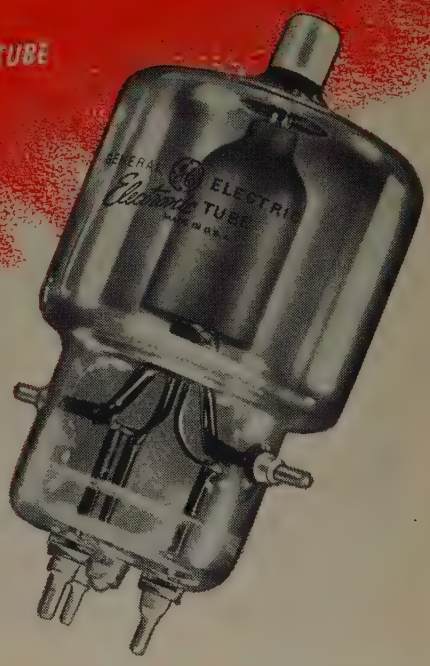
THE INSTITUTE OF RADIO ENGINEERS, INC.

1 East 79 Street, New York 21, N. Y.

Ideal tube for electronic equipment that

SEALS AND STITCHES PLASTICS

"HERE'S THE ANSWER TO YOUR NEED FOR A COMPACT, ECONOMICAL V-H-F TUBE TO POWER YOUR NEW HEATER. PROVED WIDELY IN INDUSTRY!"



PLASTIC film and sheet are "taking over" where protection from moisture or chemicals is vital. Shop-windows feature plastic rainwear. Acid-proof work garments shield from noxious liquids. Packages are plastic-sealed against dampness. Moreover, plastic wallets, handbags, novelties of all types are pouring off production lines.

Millions of yards of plastic material are being sealed and stitched, with electronic heating doing the whole job. Certainly, here's a steady, growing market for h-f-heating equipment . . . and just as surely, you want your share of this important business.

Build your circuit around General Electric's great GL-592 power tube! Its special suitability for the work, its reliability and "toughness", are industry-demonstrated. The tube carries substantial plate ratings. For still more power, a pair or two pairs may be used without undue increase in cost of the equipment. Frequency range is high. The tube is exceptionally efficient, with conversion efficiencies above 70 percent the rule in well-designed circuits. Cooling offers no problem, merely calling for an 8-inch household-type fan or a small and inexpensive pressure blower.

Ample tube stocks are available, along with sockets, grid connectors, and finned anode connectors. Specify and install—there'll be no intervening delay! You owe it to yourself as designer or builder of h-f-heating equipment to study the economical GL-592's application in *your* circuit. G-E tube engineers will be glad to assist. Phone your nearby G-E electronics office, or wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

GL-592 POWER TRIODE

Study these SUPERIOR G-E design features!

- A one-piece graphite anode, with no welds, accents the tube's mechanical strength. Zirconium coating provides excellent heat-radiating properties and helps maintain high vacuum.
- Large-diameter anode lead is sturdy, also makes for low inductance.
- The GL-592 has a combined seal-and-anode-terminal of unit construction. No cemented cap or screw connections are used. Good for the life of the tube!
- Filament leads are solidly braced for greater internal strength.
- Large-diameter G-E cup seals of matching metal and glass feature all terminals.
- External leads and seals are silver-plated for better conductivity.

RATINGS

Class C Power Amplifier and Oscillator

Filament voltage		10 v
Filament current		5 amp
Max ratings:	CCS	ICAS
d-c plate voltage	3,500 v	3,500 v
d-c grid voltage	—500 v	—500 v
d-c plate current	250 ma	350 ma
d-c grid current	50 ma	100 ma
plate input	670 w	1,000 w
plate dissipation	200 w	300 w
Type of cooling		forced-air
Frequency at max ratings		150 mc

GENERAL ELECTRIC

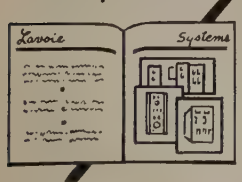
186-125

➡ *No other UHF manufacturer* offers a more varied or diversified development and design engineering staff for integrated electronic systems. . .

➡ *No other manufacturer* offers more up-to-the minute UHF shop techniques to convert your designs into complete assemblies quickly, dependably and *economically.*

We have the experience, the facilities for *precision* production and a competent understanding of government contract procedures.

This Facilities Report



shows the breadth and scope of LAVOIE LABORATORIES' facilities. Address us on your letterhead — we shall be glad to send you a copy or consult with you at your convenience.

UHF

Recent LAVOIE Projects include:

VHF OMNIDIRECTIONAL RADIO RANGE
UHF COMMUNICATION SYSTEM
MICROWAVE NAVIGATIONAL AIDS

LAVOIE Production also includes:

OSCILLOSCOPES, FREQUENCY STANDARDS, FREQUENCY METERS, SIGNAL GENERATORS AND OTHER UHF TEST EQUIPMENT

Lavoie Laboratories

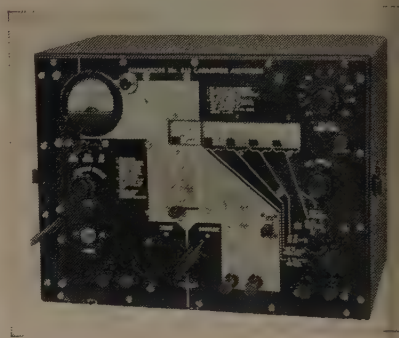
RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

News—New Product

These manufacturers have invited PROCEEDING readers to write for literature and further technic information. Please mention your I.R.E. affiliatio

Capacitor Analyzer

A new laboratory-type capacitor a alyzer meeting the need for a wide-rang direct-reading measuring instrument ca able of determining the essential characte istics of capacitors has been announced b the **Shallcross Manufacturing Co.,** 5 Pusey Ave., Collingdale, Pa.



This instrument will determine c pacitance values between 5 $\mu\mu$f and 12,0 μf; insulation resistance from 1.1 to 12,0 megohms; also leakage current, dielectr strength, and percentage power factor. divided panel carrying an outline of t operating instructions makes it readily po sible to use the instrument without refe ence to an instruction book. The analyz operates on 110-volt, 60-cps alternati current. Full details will be sent on reque to the manufacturer.

Regulated Power Supply

A new Model A3, regulated power su ply, which features flexible continuous variable dc voltage output from 0 to 4 volts with 0.5 per cent regulation at loa from 0 to 200 ma, is announced by **Oreg Electronic Mfg. Co.,** 805 S.W. Green S Portland 4, Ore. Other outputs are: 4 volts dc unregulated, 0 to 150 volts variable and stabilized, and 6.3 volts at 5 amperes.

Output ripple voltage is less than mv. Output impedance less than 10 oh dc, and less than 2 ohms from 20 cps to kc. A 40-μf capacitor may be switch across the regulated output to accomm date large peak-current loads. Meters a provided to monitor the output voltag and current.

(Continued on page 44A)

SECTION MEETINGS

ATLANTA

"Mathless Microwaves," by P. G. Nelson, Faculty, University of Florida; April 21, 1950.

BEAUMONT-PORT ARTHUR

"Recent Developments in Communications," by George Brown, Southwestern Bell Telephone Company; April 20, 1950.

BUFFALO-NIAGARA

"Sweep Frequency Impedance Measuring Techniques," by K. A. Simons, Sylvania Electric Products Inc; March 15, 1950.

"Story of Communications—Operation Sandstone," by C. L. Engleman, United States Navy; April 19, 1950.

CEDAR RAPIDS

"Bandwidth Limitations in Electrical Communication," by G. R. Town, Faculty, Iowa State College; April 18, 1950.

"One-Half Million Volt Selenium Rectifier," by R. K. Soderquist; "One Thing Leads to Another," by Gerald Luecke; and "Theory of the Magnetic Amplifier," by B. W. Lillick; May 10, 1950.

DALLAS-FORT WORTH

"The Third NARBA Conference Cuban Discussions," by J. G. Rountree and A. E. Cullum, Jr; May 3, 1950.

DAYTON

Dayton Technical Conference; May 3, 4, and 5, 1950.

DETROIT

"Electronic Measurement of Air Speed in the Supersonic Range," by J. E. Rowe, Student, University of Michigan; "Quantitative Requirements for the Reproduction of Sound," by J. R. Davies Student, University of Michigan; and "A Wide-Range Speaker System," by E. L. McIntire, Student Wayne University; April 21, 1950.

EMPORIUM

"Servomechanisms—Past, Present, and Future," by H. I. Tarpley, Faculty, Pennsylvania State College; April 25, 1950.

FORT WAYNE

"Principles of Pulse Code Modulation," by Charles Estes, Federal Telecommunication Laboratories; April 20, 1950.

"UHF and Pulse Test Equipment," by Frank Waterfall, Alfred Crossley Associates, Inc; May 10 1950.

HOUSTON

"Industrial Radar for Hurricane Tracking," by R. C. Jorgensen, Dow Chemical Company; February 21, 1950.

"APTM Microwave Communication System," by J. S. McKechnie, Federal Telephone and Radio Corporation, March 21, 1950.

"Some Recent Developments in the Field of Instrumentation," by C. S. Harrill, Oak Ridge National Laboratory; April 18, 1950.

INDIANAPOLIS

"Radar Systems and Circuits," by H. R. Whaley, Western Electric Company; Election of Officers; April 24, 1950.

LOS ANGELES

"Application of Pulse Wave form to Electrical Strain Gages," by J. C. Monroe, Student University of California at LA; "The Use of the Complex Frequency Plane," by R. L. Redden, Student, California State Polytechnic College; "A New Electronic Musical Instrument," by R. M. Strassner, Student, University of Southern California; "Communication Between Two Super-regenerative Oscillators," by S. A. Zwick, Student, California Institute of Technology; and "Trends in Engineering and Their

(Continued on page 34A)

PRECISION
RECORDING WITH THE
Variplotter

The Model 205 Variplotter, highlighting accuracy, speed, and versatility, brings to industry and laboratory a new tool with a wide field of application. This instrument will present on a 30-inch square plotting surface a precise graphic representation of one variable as a function of another variable, requiring only that the variables be expressed by d-c voltages.

ACCURACY The static accuracy is .05 percent of full scale at 70°F. The dynamic accuracy averages .05 percent of full scale plus the static accuracy at a writing speed of 8½ inches per second.

SENSITIVITY The standard sensitivity of the Variplotter is fifty millivolts per inch with other ranges of sensitivity available.

RESPONSE The maximum pen and arm accelerations are 350 and 150 inches per second squared, respectively. Slewing speeds of both pen and arm are 10 inches per second.

The Variplotter may be adapted for special use by the addition of accessories selected from our standard line—such as multiple variable conversion kits, low-drift d-c amplifiers, analog computer components; or components designed for your specific need.

YOUR INQUIRIES ARE CORDIALLY INVITED.

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH NEW JERSEY

only TORQUE E-V DRIVE gives you

everything you want

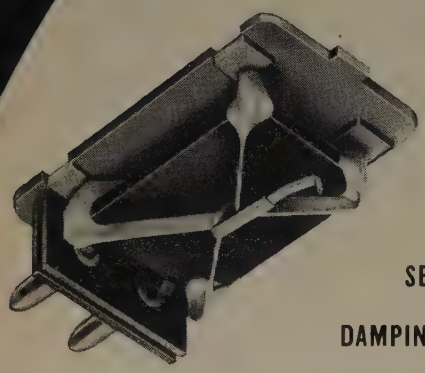
exactly as you want it!

• LOW-MASS DRIVING SYSTEM

• HIGH VOLTAGE COMPLIANCE PRODUCT

• MORE THAN ADEQUATE LATERAL COMPLIANCE

• FREQUENCY RESPONSE MATCHED TO YOUR OWN CURVE



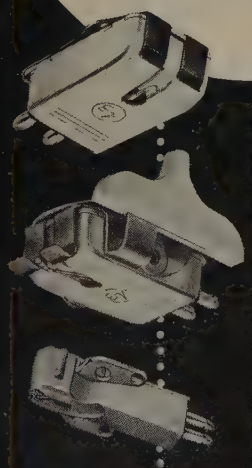
• EXTRA MOISTURE PROTECTION AT NO EXTRA COST

• NO TEMPERATURE SENSITIVE PADS OR DAMPING MATERIALS

• NO BEARINGS OR BUSHINGS TO CAUSE FRICTION

• ZERO OUTPUT FOR VERTICAL MOTIONS

• HIGH VERTICAL COMPLIANCE



A Basic Specification in Original Equipment by Leading Manufacturers

Users of E-V TORQUE DRIVE* cartridges have long enjoyed these major advantages. Advanced design and performance characteristics have made them readily adaptable to all speeds and all requirements. This has made it easy to provide the right solution for each phono cartridge problem. Laboratory control assures consistent uniformity in quantity production. Available in single-stylus and dual-stylus types . . . for 33⅓, 45 and 78 rpm single-speed or multi-speed record players. Let E-V engineers help you now. Our full facilities are at your service.

PHONO PICKUPS
MICROPHONES
SPEAKERS

Electro-Voice INC.

403 CARROLL STREET • BUCHANAN, MICHIGAN

Export: 13 East 40th Street, New York 16, N. Y., U.S.A., Cables: Arlab

*E-V Pat. Pend. Licensed under Brush Patents

SECTION MEETINGS

(Continued from page 33A)

Educational Implications," by L. M. K. Boelter, Faculty, University of California at Los Angeles; May 2, 1950.

LOUISVILLE

"The Transimutor," by S. T. Fife, Faculty, University of Louisville; April 14, 1950.

Election of Officers; May 12, 1950.

MONTREAL

"VHF, UHF, and Microwave Test Instrumentation," by F. G. Marble, Kay Electric Company; April 12, 1950.

NEW MEXICO

"Long-Distance Circuits by Microwaves," by L. M. Schindel and R. G. Hall, American Telephone and Telegraph Company; April 21, 1950.

OMAHA-LINCOLN

"A New Miniature Condenser Microphone," by J. K. Hilliard, Altec-Lansing Corporation; May 20, 1950.

OTTAWA

"VHF Communication Problems in Mobile Systems," by W. R. Wison, Royal Canadian Mounted Police; April 20, 1950.

PITTSBURGH

"Television—Why the Deep Freeze?" by S. L. Bailey, Jansky and Bailey, April 17, 1950.

"Method Analysis by Motion Pictures," by H. Carlsen; "Rockets," by L. Mathis; "Saga in Steel and Concrete," by J. Smith; "Automobile Power Supply System," by M. Saler; and "Application of Silicon Compounds to Special Electrical Insulating Problems," by H. Hunt, Students, Carnegie Institute of Technology; April 26, 1950.

PRINCETON

Rutgers University Tour; Election of Officers; May 11, 1950.

SACRAMENTO

"Expanding the Pacific Coast Telephone Network," by D. I. Cone, Pacific Telephone and Telegraph Company; April 18, 1950.

SAINT LOUIS

"Transmitting Antenna Systems for Television," by A. G. Kandoian, Federal Telecommunications Laboratories; April 27, 1950.

SALT LAKE

"Some Aspects of the Upper Air Research Project," by O. C. Haycock, Faculty, University of Utah, E. C. Madsen, Faculty, University of Utah, C. D. Westlund, C. L. Alley, G. M. Randall, T. K. Collins, and C. C. Neilson, Students, University of Utah; May 9, 1950.

SAN ANTONIO

Tour through Southwest Research Institute Laboratories; April 27, 1950.

SAN DIEGO

"Engineering Aspects of Nuclear Reactors," by A. B. Focke, United States Navy Electronics Laboratory; May 2, 1950.

SAN FRANCISCO

"Expanding the Pacific Coast Telephone Network," by D. I. Cone, Pacific Coast Telephone and Telegraph Company; March 14, 1950.

Television Symposium III; March 22, 1950.

"Properties and Applications of Ceramic Magnetic Materials," by Jack Reidel, Faculty, University of California; April 12, 1950.

Television Symposium IV; April 26, 1950.

"An UHF Television Transmitter Employing the Phase-to-Amplitude Modulation System," by W. E. Evans, Jr., Stanford Research Institute; May 10, 1950.

(Continued on page 35A)

SECTION MEETINGS

(Continued from page 34A)

SEATTLE

"United States Forest Service Radio Equipment," by Harold Lawson, United States Forest Service Laboratory; April 21, 1950.

SYRACUSE

"Dot Sequential Television Scanning," by W. P. Boothroyd, Philco Corporation; April 6, 1950.

Annual Meeting; and Election of Officers; May 4, 1950.

TOLEDO

"Serendipity, Cybernetics, and Electronics with Demonstration," by W. C. White, General Electric Company; April 19, 1950.

TWIN CITIES

"An Electronic Analogue for Heating System Analysis," by R. T. Squier and K. C. Cummings, Minneapolis-Honeywell Regulator Company; February 9, 1950.

"Hearing and Hearing Loss," by L. R. Boies, Faculty, University of Minnesota; February 23, 1950.

"A Miniature Condenser-Type Microphone," by J. K. Hilliard, Altec-Lansing Corporation; March 2, 1950.

"Industrial Television System," by R. C. Webb, Faculty, Iowa State College; April 19, 1950.

"Biological Engineering," by O. H. Schmitt, Faculty, University of Minnesota; May 11, 1950.

SUBSECTIONS

AMARILLO-LUBBOCK

Tour through United States Naval Armory; April 17, 1950.

LONG ISLAND

"Electrons in Metals," by K. K. Darrow, Bell Telephone Laboratories; May 17, 1950.

STUDENT BRANCH MEETINGS

ALABAMA POLYTECHNIC INSTITUTE, IRE BRANCH

"Ground-Controlled Approach, and Instrument Landing Systems," by Paul Nadler, Student, Alabama Polytechnic Institute; April 24, 1950.

Films; May 8, 1950.

UNIVERSITY OF ARKANSAS, IRE BRANCH

Films; May 3, 1950.

Election of Officers; May 17, 1950.

BUCKNELL UNIVERSITY, IRE-AIEE BRANCH

Election of Officers; April 12, 1950.

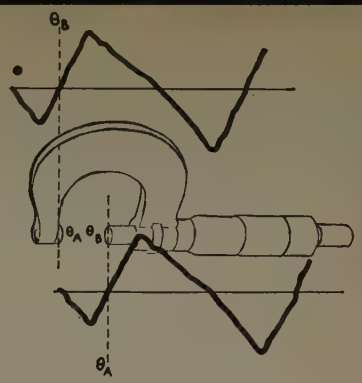
Film: "Radio-Frequency Heating," by Westinghouse Electric Corporation; April 26, 1950.

CALIFORNIA INSTITUTE OF TECHNOLOGY IRE BRANCH

"The Vidicon and the Graphicon," by Bernard Wally, Radio Corporation of America; Election of Officers; April 10, 1950.

(Continued on page 36A)

save work . . .
increase
precision . . .



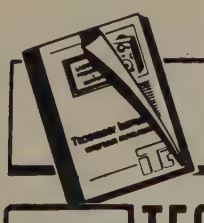
measure
phase difference
DIRECTLY

with the new TIC Phase Meter

TIC's New 320-A Phase Meter is the first commercially available instrument for the direct measurement of the phase difference between two recurrent mechanical motions or two electrical signals independent of amplitude, frequency, and wave shape.

Phase measurements are made instantly and accurately—no balances, adjustments or corrections are involved. Phase angle readings at audio and ultrasonic frequencies are indicated directly on a large wide-scale meter with ranges of 360°, 180°, 90° and 36°. Useful frequency range 2 cps. to 100 k.c.

In audio facilities, ultrasonics, servomechanisms, geophysics, vibration, acoustics, aerial navigation, electric power transformation or signaling . . . in mechanical applications such as printing register, torque measurement, dynamic balancing, textile and packaging machinery and other uses where an accurate measure of the relative position of moving parts is required . . . the Phase Meter is a long needed measuring instrument never before available — a new tool for a heretofore neglected field of measurement.

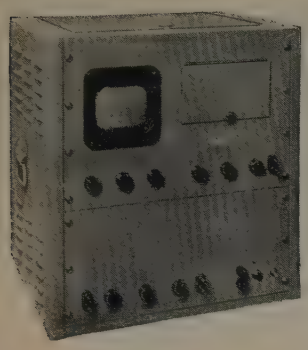


Technical Catalog — yours for the asking. Contains detailed information on all TIC Instruments, Potentiometers and other equipment. Get your copy without obligation — write today.

TECHNOLOGY INSTRUMENT CORP.
1058 Main Street, Waltham 54, Massachusetts
Engineering Representatives Cleveland, Ohio PRospect 1-6171
Chicago, Ill.—UPtown 8-1141 Dallas, Tex.—LOgan 6-5097 Rochester, N.Y.—Charlotte 3193-J
Cambridge, Mass.-ELiot 4-1751 Canaan, Conn.-Canaan 649 Hollywood, Cal.-HOllywood 9-6305

SPECTRUM ANALYSIS FROM AF TO UHF FASTER AND SIMPLER WITH THESE PANORAMIC INSTRUMENTS

These instruments help collect data more quickly, simply and objectively. Long recognized as being unexcelled for laboratory, research and production applications requiring spectrum or waveform analysis. Spectral components are visualized graphically on a cathode-ray tube as sharp vertical deflections distributed horizontally in order of frequency. Deflection height directly indicates component or signal level. Whether your problem is analyzing waveform distortions, noises, characteristics of AM, FM or pulsed signals, vibrations, spurious oscillations or modulation, response characteristics of filters or transmission lines, etc.; or monitoring many frequency channels simultaneously, it will pay you to investigate these panoramic analyzers.



PANORAMIC SONIC ANALYZER, MODEL AP-1
Automatic Waveform Analysis in Only 1 Second

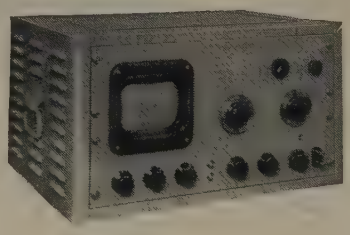
Accepted as the PRACTICAL ANSWER, for truly simple high speed analysis of vibrations, harmonics, noises, acoustics and intermodulation under static or dynamic conditions, the AP-1 automatically separates and measures frequency and magnitude of complex audio wave components.

Frequency Range	40-20,000 cps, log scale
Input Voltage Range	500uV-500V
Voltage Scale	Linear and two decade Log
Resolution	Optimum throughout frequency range

Presentations easily photographed or recorded. Can be calibrated for determining level of individual sound or vibrational components.

Panoramic Response Indicator for checking frequency transmission characteristics of lines, filters, speakers, etc., plus Intermodulation Analyzer-optional.

PANORAMIC ULTRASONIC ANALYZER, MODEL SB-7
A New Direct Reading Spectrum Analyzer



An invaluable instrument for channel monitoring, telemetering, medical studies, and for investigating ultrasonic waveform content and ultra audible noises and vibrations, the SB-7 allows overall observation of a 200KC wide band or highly detailed examination of selected narrow bands.

Frequency Range: 2KC-300KC, linear scale
Scanning Width: Continuously variable, 200KC to zero
Amplitude Scale: Linear and two decade Log.
Input Voltage Range: 1mV-50V.
Resolution: Continuously variable from 2KC to better than 500 CPS.

PANADAPTOR SA-3, SA-6 PANALYZOR SB-3, SB-6
For General RF Spectrum Analysis

Recognized as the fastest and simplest means of investigating and solving such RF problems as frequency stability, modulation characteristics, oscillations, parasitics and monitoring under static or dynamic conditions, these models are available in over a dozen different types, designed to meet your particular application.

Panadaptor units operate with superheterodyne receivers which tune in the spectrum segment to be observed.

Panalyzors use an external signal generator for this purpose and have a flat response for determining relative levels of signals.

PANADAPTOR, SA-8 PANALYZOR SB-8
For RF Spectrum Analysis where Maximum Resolution is a "Must"

Available in several types with maximum scanning widths ranging from 200KC to 20MC, both the SA-8 and SB-8 feature. . . .

- Continuously Variable Resolution from 100KC to 100cps
- Synchronous and Non-synchronous Scanning
- Long Persistence Displays plus Intensity Grid Modulation for Analysis of Pulsed RF Signals
- Continuously Variable Scanning Width from Maximum to Zero

Write Dept. WC7 for complete specifications and prices

PANORAMIC RADIO PRODUCTS Inc.
19 SOUTH SECOND AVE MOUNT VERNON N Y

(Continued from page 35A)

CARNEGIE INSTITUTE OF TECHNOLOGY, IRE-AIEE BRANCH

Student Talks; March 22, 1950.
Student Talks; March 29, 1950.
Student Talks; April 19, 1950
Student Talks; May 10, 1950.
Student Talks; May 17, 1950.

CASE INSTITUTE OF TECHNOLOGY, IRE BRANCH

"Cybernetics," by Dr. Alexander, Faculty, Western Reserve University; April 12, 1950.

"Radiation Measurements," by Dr. Victurine, Victurine Corporation; April 25, 1950.

CLARKSON COLLEGE OF TECHNOLOGY, IRE BRANCH

"Other Uses of Electrons," by T. S. Renzema, Faculty, Clarkson College of Technology; Election of Officers; April 20, 1950.

Film; May 4, 1950.

CORNELL UNIVERSITY, IRE-AIEE BRANCH

"Construction of WOR-TV," by Charles Singer, Radio Station WOR-TV; Election of Officers; April 21, 1950.

UNIVERSITY OF DAYTON, IRE BRANCH

"Colored Television," by William Horst, Student, University of Dayton; February 7, 1950.

"Geiger Counters," by Henry Kampf, Student, University of Dayton; February 14, 1950.

"Commercial Radio Operator's License," by Kenneth Bornhorst, Student, University of Dayton; February 21, 1950.

"Servomechanisms," by Joe Day, Student, University of Dayton; February 28, 1950.

"Wobbulators," by Paul Hennessy, Student, University of Dayton; March 7, 1950.

"Technical Conference," by Roy Hearsum; March 14, 1950.

"Signal Tracing," by Thomas Dinan, Student, University of Dayton, March 28, 1950.

"Electronic Civil Service Employment," by James DeLuna, Student, University of Dayton; April 4, 1950.

"Transistors," by Robert Tanis, Student, University of Dayton; April 11, 1950.

"Supermodulation," by Howard Pritchard Student, University of Dayton; and "Number Systems," by William Puterbaugh, National Cash Register Company; April 18, 1950.

"Interval Timers," by Terry Lorenz, Student, University of Dayton; April 25, 1950.

GEORGIA INSTITUTE OF TECHNOLOGY, IRE BRANCH

"Velocity Modulation Television," by David Prince, Faculty, Georgia Institute of Technology; May 4, 1950.

ILLINOIS INSTITUTE OF TECHNOLOGY, IRE BRANCH

"1FF Systems," by C. D. Pierson, Faculty, Illinois Institute of Technology; April 20, 1950.

"The Analog Computer," by DeWitt Pickens. Armour Research Foundation; Election of Officers; May 18, 1950.

STATE UNIVERSITY OF IOWA, IRE BRANCH

Films; May 3, 1950.
Film: "The Telephone Hour"; May 17, 1950.

IOWA STATE COLLEGE, IRE-AIEE BRANCH

Technical Papers Presentation; April 19, 1950.

"A Survey of Electrical Engineering Applications in Nuclear Physics," by Glen Miller, Faculty, Iowa State College; April 28, 1950.

(Continued on page 37A)

(Continued from page 36A)

JOHN CARROLL UNIVERSITY, IRE BRANCH

"The Oscilloscope," by Robert McNally, Student, John Carroll University; March 30, 1950.

Panel Discussion: "Are We Prepared for Color Television"; April 27, 1950.

"The Maximeter," by E. F. Carome, Student, John Carroll University; May 4, 1950.

LAFAYETTE COLLEGE, IRE-AIEE BRANCH

"Summer Work with Public Service," by Eugene Rycharski, and "Instruments," by Henry Krautter, Students, Lafayette College; April 13, 1950.

"The Watthour Meter," by Graham Hoffman, Student, Lafayette College; Election of Officers; May 18, 1950.

Picnic; May 19, 1950.

LEHIGH UNIVERSITY, IRE BRANCH

Field Trip; American Telephone and Telegraph Repeater Station; Election of Officers; May 4, 1950.

UNIVERSITY OF LOUISVILLE, IRE BRANCH

Election of Officers; April 27, 1950.

UNIVERSITY OF MAINE, IRE BRANCH

"Experiences at The Institute of Radio Engineers' Regional Convention in New York," by W. J. Creamer and P. M. Seal, Faculty, University of Maine; "Summer Employment," by Earl Dawley and Charles Stokes, Students, University of Maine; March 16, 1950.

"Tube Characteristics on CRT," by Herbert Ingraham, Student, University of Maine; April 25, 1950.

MANHATTAN COLLEGE, IRE BRANCH

"Heat Pump and Applications," by T. C. Johnson, General Electric Company; April 19, 1950.

Election of Officers; May 3, 1950.

MARQUETTE UNIVERSITY, IRE-AIEE BRANCH

Financial Report; April 27, 1950.

Business Meeting; May 11, 1950.

MICHIGAN COLLEGE OF MINING AND TECHNOLOGY, IRE-AIEE BRANCH

Business Meeting; Election of Officers; May 16, 1950.

MICHIGAN STATE COLLEGE, IRE-AIEE BRANCH

"Electric Home Heating by Radiant Heating Panels," by E. W. Renfree, United States Rubber Company; April 4, 1950.

"Silicone Electrical Insulations," by G. E. McIntyre, Dow Corning Corporation; Election of Officers; April 12, 1950.

Films: "Disconnecting Switches," "Industrial Distribution Systems," and "Summer Storm"; April 26, 1950.

UNIVERSITY OF MICHIGAN, IRE-AIEE BRANCH

"Power Plant Layout," by H. A. Wagner, Detroit Edison Company; April 26, 1950.

MISSOURI SCHOOL OF MINES & METALLURGY, IRE-AIEE BRANCH

"Metallic Rectifiers," by F. A. Waelterman, Vickers Electric Division; April 26, 1950.

UNIVERSITY OF NEBRASKA, IRE-AIEE BRANCH

Business Meeting; Election of Officers; May 3, 1950.

NEWARK COLLEGE OF ENGINEERING, IRE BRANCH

"Automatic Measurement and Spectrographic Presentation of Audio and RF Spectrum," by Bert Schlessel, Panoramic Radio Products, Inc; April 6, 1950.

(Continued on page 38A)

Specify CP TEF-LINE SUPER TRANSMISSION LINE

A new transmission line based upon a new plastic—TEFLON

CP TEF-LINE transmission line, utilizing DuPont Teflon insulators, greatly reduces high frequency power losses. Furthermore, operation of transmission line at frequencies heretofore impossible owing to excessive power loss now becomes easily possible. For TV, FM and other services utilizing increasingly high frequencies, TEF-LINE by CP is a timely and valuable development worthy of investigation by every user of transmission line.

ONE-PIECE
INNER CONDUCTOR
Seal-O-Flange Tef-Line is made of a single piece of copper tubing. Teflon disks are distributed to provide positive, permanent positioning.
COPPER INNER CONDUCTOR OF A TEF-LINE SEAL-O-FLANGE TRANSMISSION LINE SHOWING A ONE-PIECE TEFLON INSULATING DISK FITTING INTO DEPRESSION FORMED IN THE TUBE WALL

CP SUPER TEF-LINE IS AVAILABLE NOW!

Tef-Line can be delivered immediately in three standard sizes—⅞", 1⅝" and 3⅛". With the exception of elbows and gas stops, the new Seal-O-Flange Super Transmission Line is interchangeable with all other CP fittings including end seals, tower hardware, flanges, "O" rings, inner conductor connectors and miscellaneous accessories.

Check your transmission line requirements with the new CP TEF-LINE BULLETIN which is available on request. If you need help in planning installations, our engineers will be happy to talk over specific problems at your convenience.

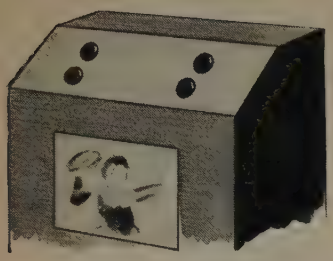
• TOWER HARDWARE • AUTO-DRYAIRE DEHYDRATORS
• LO-LOSS SWITCHES • COAXIAL DIPOLE ANTENNAS
• SEAL-O-FLANGE TRANSMISSION LINE

Communication Products Company, Inc.

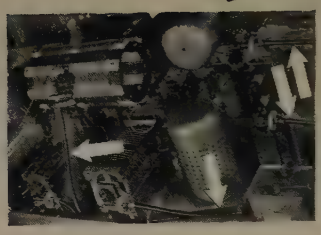
KEYPORT NEW JERSEY

CHIEF ENGINEER FLEXY SAYS:—

"HERE ARE TWO PLACES WHERE S.S.WHITE FLEXIBLE SHAFTS CAN HELP YOU"



CABINET DESIGN



CIRCUIT DESIGN

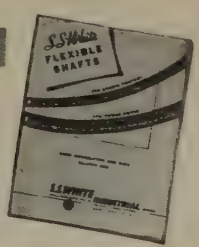
"Many of the problems met in designing circuits and cabinets can be greatly simplified by using S.S.White flexible shafts to connect variable elements to their control knobs.

"Here's why. Irrespective of where you locate an element or its control, you need only a single, easily applied flexible shaft to connect the two. This gives you almost unlimited freedom in the placement of coupled parts and permits you to develop cabinet and circuit designs to get top electrical efficiency, better appearance, more convenient operation, and to meet space, assembly and wiring requirements.

"S.S.White flexible shafts have proved to be a successful answer to these problems in many electronic and radio devices including broadcast transmitters, diathermy units, AM and TV receivers and radar equipment. It will pay you to consider their use in your equipment."

WRITE FOR BULLETIN 4501

It contains basic facts and data on flexible shaft selection and application. Copy sent on request. Write today.



S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. DEPT. G 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

One of America's AAAA Industrial Enterprises

Student Branch Meetings

(Continued from page 37A)

"Digital Computer," by Norman Greenberg, Faculty, Newark College of Engineering; April 25, 1950.

UNIVERSITY OF NEW MEXICO, IRE BRANCH

Tour of Public Service Company of New Mexico; December 7, 1949.

Film: "RF Induction Heating"; Election of Officers; May 17, 1950.

COLLEGE OF THE CITY OF NEW YORK, IRE BRANCH

"Facsimile Communications," by John Shonnard, Times Facsimile Corporation; April 6, 1950.

NEW YORK UNIVERSITY, IRE BRANCH (DAY DIVISION)

Election of Officers; April 20, 1950.

"Resistance Measurements up to 100,000 Meghoms," by W. J. Long, J. G. Biddle Company; April 13, 1950.

Tour through Westinghouse Lamp Division; May 10, 1950.

UNIVERSITY OF NOTRE DAME, IRE-AIEE BRANCH

"Instrumentation," by Frederick Koppel, J. G. Biddle Company; May 8, 1950.

OHIO STATE UNIVERSITY, IRE-AIEE BRANCH

"Is There a Place for Electrical Engineers in the Public Utility Field?" by Ivon Ulrey, Faculty, Ohio State University; April 20, 1950.

Tour of Pickaway Generating Plant, and Columbus and Southern Ohio Electric Company; May 4, 1950.

PENNSYLVANIA STATE COLLEGE, IRE-AIEE BRANCH

"Silicone Electrical Insulation," by Carl Christiansen, Dow Corning Corporation; Election of Officers; April 24, 1950.

Tour of Sylvania Electric Products Inc.; April 25, 1950.

Prize Paper Competitions; April 28, 1950.

Tour of Pennsylvania Power and Light Company; April 29, 1950.

"What Do We Do Now," by E. B. Stavely, Faculty, Pennsylvania State College; May 2, 1950.

Films; "Adventures in Research," "Lubrication Ain't No Problem," "What Price Motors," and "Electronics at Work"; May 4, 1950.

"Antenna Problems and Equipment of WOR-TV," by C. H. Singer, Radio Station WOR-TV; May 11, 1950.

PRATT INSTITUTE, IRE BRANCH

Business Meeting; Election of Officers; May 3, 1950.

RHODE ISLAND STATE COLLEGE, IRE-AIEE BRANCH

Business Meeting; May 18, 1950.

RUTGERS UNIVERSITY, IRE-AIEE BRANCH

Election of Officers; May 2, 1950.

SEATTLE UNIVERSITY, IRE BRANCH

Film: "World's Largest Electrical Shop"; Election of Officers; May 19, 1950.

UNIVERSITY OF SOUTHERN CALIFORNIA IRE-AIEE BRANCH

"Design of 1-Kw Broadcast Transmitter," by L. A. Hoffman, R. F. Denton, and A. Broder, Students, University of Southern California; April 20, 1950.

(Continued on page 39A)

Student Branch Meetings

(Continued from page 38A)

Tour of Analogue Computer and High Voltage Laboratory, by Dr. Tejada-Flores, Faculty, University of Southern California; April 27, 1950.

Tour of Hoover Dam and Davis Dam; May 6, 1950.

"Engineering Ethics," by E. H. Morris, Westinghouse Electric Corporation; May 10, 1950.

"Single Sideband Communication," by M. C. Swarm, Faculty, University of Washington, April 28, 1950.

STANFORD UNIVERSITY, IRE-AIEE BRANCH

"Job Opportunities for Graduate Engineers," by Noel Eldred, Hewlett Packard Company; April 12, 1950.

Tour of Hewlett Packard Company; April 21, 1950.

SYRACUSE UNIVERSITY, IRE-AIEE BRANCH

Presentation of Student Papers: "The Use of Electro Mechanical Analogies in the Investigation of the Riding Qualities of an Automobile," by J. E. McDermett; "A Practical Survey of Analog Computers," by S. L. Rosing; and "High-Voltage Direct-Current Transmission," by F. P. O'Connor, Students, Syracuse University; April 20, 1950.

TUFTS COLLEGE, IRE-AIEE BRANCH

"Rocket Project," by A. H. Howell, Faculty, Tufts College; May 10, 1950.

UNIVERSITY OF WYOMING, IRE BRANCH

Film: "Impregnated Paper Insulated Cables," by Okonite-Calendar Company; April 6, 1950.

"Wyoming Highway Department Radio," by Jack Neubar, Wyoming Highway Department; Election of Officers; April 20, 1950.

YALE UNIVERSITY, IRE-AIEE BRANCH

Presentation of Student Papers: "An Empirical Approximation to the Magnitization Curve," by James Bartram, and "An *E*-Field Microwave Rotating Joint," by Allen Perrins, Students, Yale University; Election of Officers; April 25, 1950.

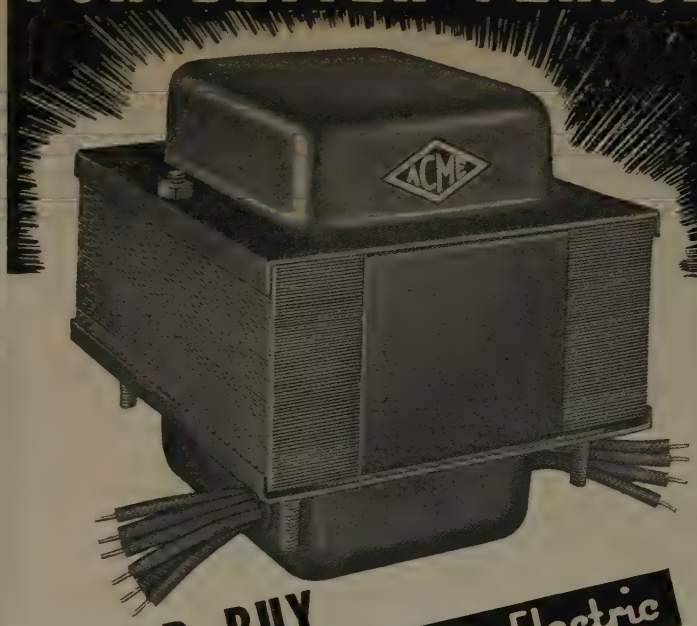
The following transfers and admissions were approved and will be effective as of July 1, 1950:

Transfer to Senior Member

Bailey, R. S., 3349 N. 44 St., Phoenix, Ariz.
Carlson, C. G., 11617 Judah Ave., Inglewood, Calif.
Coles, D. K., Westinghouse Research Laboratories, E. Pittsburgh, Pa.
Eichwald, B., 2054 E. 21 St., Brooklyn 29, N. Y.
Feikert, G. S., 321 N. 23 St., Corvallis, Ore.
Gehres, F. A., 2232 E. Powell Ave., Evansville 14, Ind.
Gull, R. A., 419 Tremont Ave., Kenmore 17, N. Y.
Hamilton, W. H., 95 Earlwood Rd., Pittsburgh 21, Pa.
Hoehn, A. J., Jr., Electrical Engineering Division, Armour Research Foundation, Chicago 16, Ill.
Jones, T. L., 324 E. 11 St., Kansas City 6, Mo.
Krauss, H. L., Dunham Laboratory, Yale University, New Haven, Conn.
Lepley, R. C., R.F.D. 2, Emporium, Pa.
Mason, F. L., Electronics Office, Naval Shipyard, Pearl Harbor, T. H.

(Continued on page 40A)

FOR BETTER PERFORMANCE



Output characteristics of television transformers must match the circuit exactly.

Acme Electric transformers are custom engineered to your specifications.

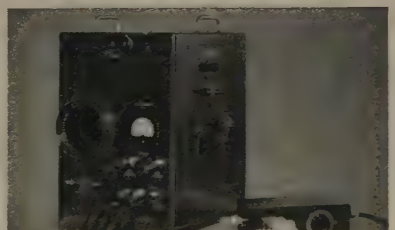
(illustrated) Television Power Transformer with copper shorting band.

BETTER BUY Acme Electric TRANSFORMERS

ACME ELECTRIC CORPORATION • 447 Water St., Cuba, N.Y., U.S.A.

Acme Electric TRANSFORMERS

Test Equipment FOR RADAR and PULSE APPLICATIONS



MODEL 705 WOBBULATOR

Swept signal output with center frequency adjustable from 2 to 500 mc.
Continuous swept output adjustable from 0 to 100 mc./sec. with 0.1 volt output at 50 ohms.
Internally synchronized scope with detectors and amplifiers.
High and low impedance shielded traveling detectors.
Output designed for making response measurements at 3000 mc., IF frequencies, and Video.

MODEL 708 SPECTRUM ANALYZER

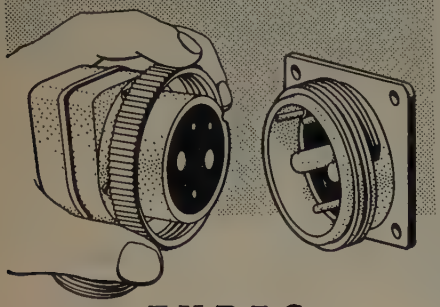
Frequency range—8500 mc to 9600 mc.
IF bandwidth—approximately 100 kc.
Sweep frequency—10 cps to 25 cps.
Minimum frequency dispersion—1 mc/inch.
Maximum frequency dispersion—10 mc/inch.
Signal input attenuator—100 db linear.
Power—115V or 230V, 50 cps to 800 cps.

Write for complete technical data

Canoga Corporation

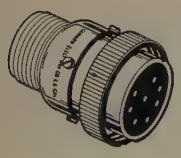
14315 Bessemer St., Van Nuys, Calif. • Box 361

A LONG AND DISTINGUISHED LINE OF CANNON PLUGS

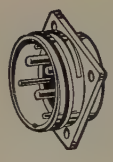


TYPES K AND RK CONNECTORS

for radio, television, instrument and general electrical and electronic circuits

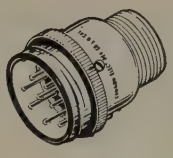


K



PLUG RECEPTACLE

RK



RECEPTACLE PLUG

WK–C3

Cannon Electric K and RK plugs and receptacles include 14 shell types in 8 sizes with 199 insert (layout) arrangements. The line includes 6 accessory fittings. Contact capacities include 10, 15, 30, 40, 60, 80, 115 and 200-amperes. Conduit and cable clamp entries accommodate Navy, Air Corps and A-N threads. The special acme thread of the coupling nut assures long service, fewer turns for engagement.

New K3-1950 Bulletin on request.

Write to Cannon Electric Development Company, Division of Cannon Manufacturing Corporation, 3209 Humboldt Street, Los Angeles 31, California or contact one of the 28 Cannon representatives located in principal U. S. A. cities. Canadian plant and offices: Toronto, Ontario. Export: Frazar & Hansen, San Francisco, California.

SINCE 1915 CANNON ELECTRIC

MEMBERSHIP

(Continued from page 39A)

McAllister, J. F., Jr., 121 Ruskin Ave., Syracuse 4, N. Y.
McCoy, F. G., R.F.D. 4, Box 452-J, Charleston, S. C.
Mesner, M. H., Kingston Rd., Princeton, N. J.
Meyer, R. G. H., Coles Signal Laboratory, Red Bank, N. J.
Minnium, B. B., Edinboro Rd., R.F.D. 3, Erie, Pa.
Montgomery, L. H., Jr., Radio Station WSM, Nashville 3, Tenn.
Peskin, E., 467 Central Park West, New York City 25, N. Y.
Rod, R. L., Melpar, Inc., 452 Swann Ave., Alexandria, Va.
Scheer, F. H., College Park, Lewisburg, Pa.
Scheuch, D. R., 1727 38 Ave., San Francisco, Calif.
Sears, J. F., 1736 Washington Ave., Evansville 14, Ind.
Serniuk, W., 81 Bayberry Dr., Huntington Station, L. I., N. Y.
Sleeper, G. E., Jr., 730 Grizzly Peak Blvd., Berkeley 8, Calif.
Smith, C. McR., Jr., 403 W. First St., Winston-Salem 7, N. C.
Smith, N. F., Spruce St., Riverside, Conn.
Stacy, J. E., 84 Faun Bar Ave., Winthrop 52, Mass.
Thomas, H. E., Allen B. DuMont Labs., 35 Market St., E. Paterson, N. J.
Wholey, W. B., 342 Verano Dr., Los Altos, Calif.
Williams, L. E., Electrical Engineering Dept., University of Connecticut, Storrs, Conn.
Winzemer, A. M., 2142 Longshore Ave., Philadelphia 24, Pa.
Wischmeyer, C. R., Box 1892, Rice Institute, Houston 1, Tex.
Wulfsberg, A. H., 1125 33 St., S.E., Cedar Rapids, Iowa

Admission to Senior Member

Boyer, J. M., 189-15 37 Ave., Flushing, L. I., N. Y.
Brown, J. F., Box 131, San Carlos, Calif.
Cox, G. M., 154 Victoria St., S., Kitchener, Ont., Canada
Farinon, W. B., 1319 Mokulua Dr., Lanikai, Oahu, T. H
Guenard, P. R. G., 23, Rue du Maroc, Paris, France
Guterman, H. C., 956 Fifth Ave., New York 21, N. Y.
Hallden, F. C., 264-16 82 Ave., Floral Park, L. I., N. Y.
Hearn, O. E., Alden Rd., Huningdon Valley, Montgomery Co., Pa.
McCreary, R. L., Collins Radio Co., Cedar Rapids, Iowa
McDonald, D. C., Box 173, 10 E. McDonald Rd., Prospect Heights, Ill.
Mehaffey, W. R., 1174 S. Scoville Ave., Oak Park, Ill.
Middleton, A. D., Tijeras, N. Mex.
Morton, E. R., 32 Schermerhorn St., Brooklyn 2, N. Y.
O'Neal, R. D., 3012 Brookman Blvd., Ann Arbor, Mich.
Rado, J. A., 11 Thatcher St., New London, Conn.
Randall, G. A., 26 Marion Ave., Merrick, L. I., N. Y
Ressler, H. C., 39-02 214 Pl., Bayside, L. I., N. Y.
Stout, M. B., 2509 E. Engineering Bldg., University of Michigan, Ann Arbor, Mich.

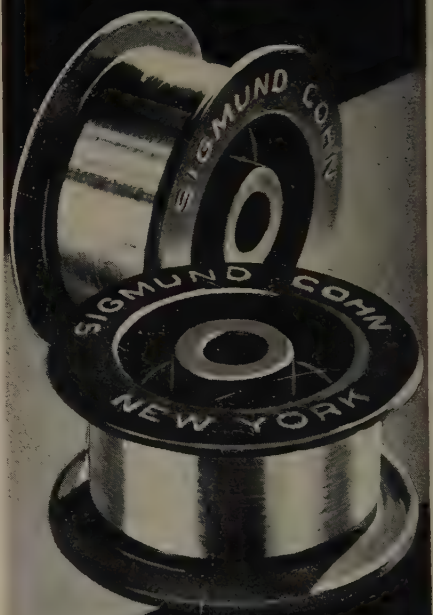
Transfer to Member

Brown, J., 40 Monroe St., New York 2, N. Y.
Fuqua, C. E., Western Air Lines, Inc., Stapleton Air Field, Denver 7, Colo.
Haegele, R. W., 53-15 213 St., Bayside, L. I., N. Y.
Hearsum, D. R., 128 Orange Ave., Dayton 9, Ohio
Kelley, J. R., 6005 E. Pine Dr., Riverdale, Md.
Lawrence, N. S., Johnson's Corners, R.F.D. 1, Harpursville, N. Y.

(Continued on page 41A)

Gold Plated

TUNGSTEN *and* MOLYBDENUM GRID WIRE



Made to meet your specifications . . . for gold content, diameter and other requirements.

Write for details and list of products

SINCE 1901

SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

(Continued from page 40A)

Lucas, F. B., 836 N.E. 88 St., Miami 38, Fla.
McNatt, W. E., 2433 Elder Lane, Franklin Park, Ill.
Merrill, J., 16 Granada Ter., New London, Conn.
Miller, C. M., 975 Cayuga Ave., San Francisco 12, Calif.
Murphy, R., 8410 St. Clair Ave., Rossmoyne 36, Ohio
Padalino, J. J., 450 S. Clinton St., East Orange, N. J.
Patel, S. N., 10 Kamalabai St., Theagaroyanagar, Madras 17, India
Pettingill, S. A., 702 Manor Rd., #303, Alexandria, Va.
Pritchett, W. S., Division of Electrical Engineering, University of California, Berkeley 4, Calif.
Powers, J. S., 4035 N. Mozart St., Chicago 18, Ill.
Robertson, R. E., 3207 Fayette Rd., Kensington, Md.
Schulz, R. B., 515 W. Wyoming Ave., Philadelphia, Pa.
Sheingold, A., U. S. Naval Post Graduate School, Annapolis, Md.
Shreve, T. S., 1230 Valentia St., Denver 7, Colo.
Steppler, R. V., 1122 Cataline Blvd., San Diego 7, Calif.
Van Rennes, A. B., Rm. 4-234, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge 39, Mass.
Yoder, L. E., 1116 W. Berry, Fort Wayne 2, Ind.

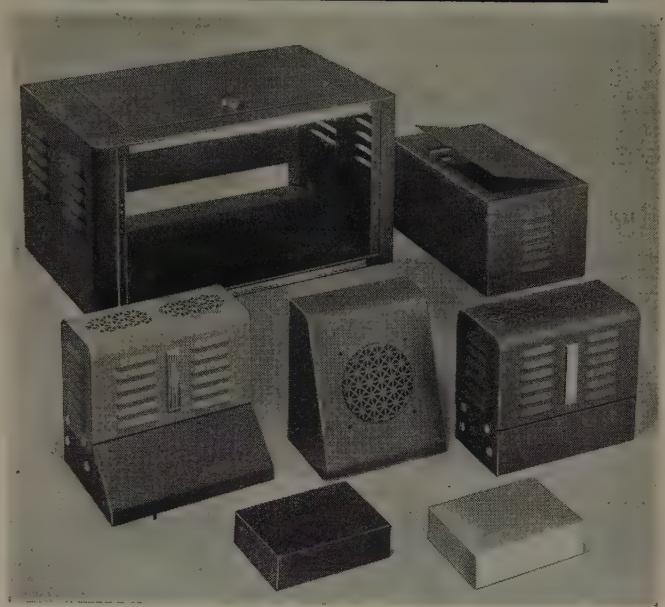
Admission to Member

Beard, R. G., Box 8400, Johannesburg, S. Africa
Berkowitz, B., 147-11 Hoover Ave., Jamaica 2, L. I., N. Y.
Blanchard, R. R., Box 66, Longmont, Colo.
Brett, G. F., c/o E. S. Dean, 23-25 Beaver St., New York 4, N. Y.
Cameron, D. F., 919 Linden St., Shreveport 27, La.
Champness, N. A., 6D The Roger Williams, Kew Gardens, L. I., N. Y.
Edwards, F. W., 7007 Sheridan Rd., Chicago 26, Ill
Esten, P. W., 120 Cambridge Dr., Louisville 8, Ky.
Garvey, E. J., 2 Mitchell Ave., Poughkeepsie, N. Y.
Grace, F. C., 50 W. 97 St., New York, N. Y.
Graham, R. H., Engineering Development Division, Allis Chalmers Manufacturing Co., Box 512, Milwaukee 1, Wis.
Harper, L. R., 10 D Muldowney Circle, Poughkeepsie, N. Y.
Hollenberg, A. V., Bell Telephone Laboratories, Murray Hill, N. J.
Jones, A. W., R.F.D. 1, 503 Scarlett Rd., Weston, Ont., Canada
Kingan, J. J., 4008 Wilson Ave., Montreal, Ont., Canada
Knights, J. E., Jr., 6113 62 St., Middle Village, Queens, N. Y.
Kuffel, L. A., 5132 Wrightwood Ave., Chicago 39, Ill.
Mercer, I., Box 1380, Radio Station KHON, Honolulu, T. H.
Mills, R. L., 2307 Alaska, Dallas 16, Tex.
Muehlner, J. W., Ord. Res. & Dev. Div. Sub O. (Rocket), Fort Bliss, Tex.
Pool, K. C., 5275 Portland Ave., White Bear Lake, Minn.
Searle, L. H., Philco Corporation, Sandusky, Ohio
Shanahan, J. C., Box 64, Normandy Beach, N. J.
Slade, B. N., 114 Franklin St., E-2, #3, Morristown, N. J.
Solt, H. B., 34-41 78 St., Jackson Heights, L. I., N. Y.
Stadig, S. V., 3 Stadium Pl., Allston 34, Mass.
Stevens, H. E., 1888 Beersford Rd., E. Cleveland, Ohio
Sussman, E. B., 4 St. Quintin Ave. 19, London, North Kensington W.10, England

(Continued on page 42A)

Got a Problem?

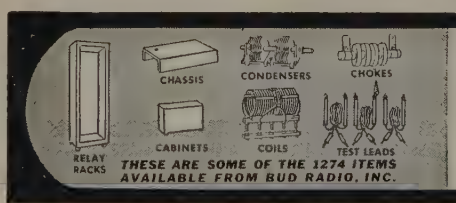
IN SHEET METAL



Regardless of your need for sheet metal housings, we probably have a stock item that will fulfill your requirements. **OFTEN A SLIGHT CHANGE IN ONE OF OUR STANDARD MODELS WILL ELIMINATE THE NECESSITY OF A SPECIAL DESIGN.** Of course we are always glad to quote on any steel or aluminum chassis, box, or cabinet directly from your blue print.

Our facilities, years of experience and "know-how" assure you that you always get the highest quality at the lowest price.

Whether your requirements are **ONE OR A MILLION,** you will save time and money by consulting us first. The Bud catalog gives complete, concise description of all our products including sizes, applications and prices. Write for a copy today.



BUD RADIO, INC.

BUD

2110 E. 55th ST. • CLEVELAND 3, OHIO

ONE OF OUR

PRECISION PRODUCTS FACSIMILE LEAD SCREW

28" LONG

12 5/8" OF 96 PITCH THREAD
SHAFT DIAMETER 0.6250" ± .0002"
CONCENTRICTY THROUGHOUT .0003"

MANUFACTURERS THREAD GRINDING, INC.

P. O. Box 66 EATONTOWN, N. J. ASBURY PARK 1-1019

New "MIGHTY MITES"

Seletron

SELENIUM RECTIFIERS

Rectifiers are shown actual size

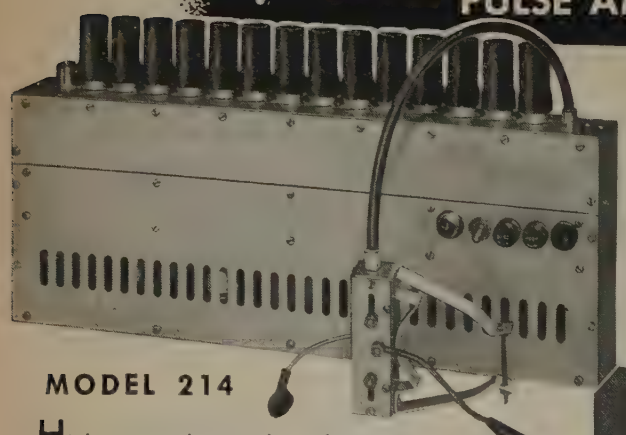
CHALK UP another First for SELETRON! Here is "mite-size" 8J1, keyed to the requirements of modern electronic circuits . . . A new and *smaller* 65 mil rectifier with particularly low reverse leakage, built to the following specifications: Input 130 V rms; Max. Peak Inverse Voltage 380 V; Max. D.C. Output Current 65 MA; Plate Size 11/16" square; Stack Thickness 9/16".

. . . And don't forget the 20 Mil "Mite"—No. 8Y1, designed especially for power and bias supply in Radio and Television!

A complete tabulation of all SELETRON miniatures is available. For your copy, write Dept. RE-4.

SELETRON DIVISION
RADIO RECEPTOR COMPANY, INC.
Since 1922 in Radio and Electronics
Factory: 84 North 9th St., Brooklyn 11, N. Y. • Sales Departments: 251 West 19th St., New York 11, N. Y.

Now SKL's NEW
100 MC BANDWIDTH
PULSE AMPLIFIER



FEATURES

OUTPUT VOLTAGE
65 volts

RISE TIME
.006 usec.

GAIN
30 db

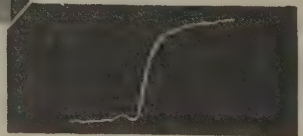
INPUT IMPEDANCE
180 ohms

BANDWIDTH
40 KC to 100 MC

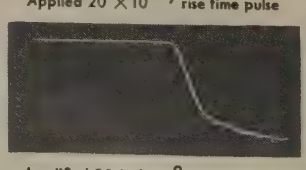
MODEL 214

High output voltage and very fast rise time with NO OVERSHOOT characterize the performance of the SKL Model 214 Chain Pulse Amplifier. The specially designed terminating cable provides a resistive output of 500 ohms and a capacitive output for connection to a cathode ray tube grid or deflection plates. Capable of deflecting a 5XP tube more than 1", the Model 214 finds extensive use in radar, oscillography, television testing, and nuclear physics.

Write today for further information.



Applied 20 $\times 10^{-9}$ rise time pulse



Amplified 20 $\times 10^{-9}$ rise time pulse

SKL SPENCER-KENNEDY LABORATORIES, INC.
181 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

MEMBERSHIP

(Continued from page 41A)

Tanguy, D. R., Box 2175, Houston 1, Tex.
Underhill, G. H., 2 N. Randolph Ave., Poughkeepsie, N. Y.
Vogel, R. Q., 33-18 207 St., Bayside, L. I., N. Y.
Vordermark, E. B., Radio Station WMBR, Box 5187, Jacksonville, Fla.
Walsh, J. E., 33 Barnesdale Rd., Natick, Mass.
Warner, D. E., 3801 Dublin Ave., Los Angeles 8, Calif
Williams, J. V., Jr., 5 Pilgrim Ter., Poughkeepsie, N. Y.
Williams, R. W., Drawer 2038, Pittsburgh 30, Pa.
Wimer, A. G., Jr., 395 Broad St., Eatontown, N. J.
Witt, C. E., 3114 Charles St., Melrose Park, Ill.
Fox, C. H., 3516 Love Field Dr., Dallas 9, Tex.

The following elections to Associate grade were approved and are effective as of June 1, 1950:

Anderson, W. J., 416 W. Sixth St., Emporium, Pa.
Backman, M. E., B.O.Q. "B" Rm. 112, U.S.N.-O.T.S., China Lake, Calif.
Baker, H. C., 25 E. Second St., Clifton, N. J.
Bartel, R. C., 615 W. Jefferson St., Fort Wayne, Ind.
Bleasdale, W. W., 7 Blackburn Rd., Accrington, Lancs., England
Bochet, F. J., 216 Adams Ave., River Edge, N. J.
Boisvert, E. L., 147 E. Duval St., Philadelphia 44, Pa
Bowman, H. A., 2619 Newton St., Silver Spring, Md.
Brager, C. H., 7006 Aspen Ave., N.W., Tacoma Park, Md.
Campbell, B., 3627 E. 56 St., Maywood, Calif.
Christopher, J. R., 323 N. Ewing, Dallas 8, Tex.
Cole, J. A., 7234 S.W. 54 Ave., Portland, Ore.
Colgan, A. R., 718 Quincy St., Rapid City, S. Dak.
Coleman, H. B., 15831 Normandy, Detroit 21, Mich.
Connely, R., Jr., 815 N. Market St., Inglewood, Calif.
Cornell, J. A., 6847 Rosemont Ave., Camden 5, N. J.
Cruse, P. M., 1311 Euclid St., Santa Monica, Calif.
Curtis, R. W., 235 Beaverbrook St., Winnipeg, Man., Canada
Czarnecki, E. J., 4416 N. Malden St., Chicago 40, Ill.
Delgado, R., 2407 Cameron Lane, Box 54, Isle of Palms, S. C.
Dember, A. B., 5-B Wasp Cir., China Lake, Calif.
Diven, L., 225 W. 106 St., New York 25, N. Y.
Doyle, R. J., 40 Highland Ave., Mt. Kisco, N. Y.
Eckert, E. R., 10956 W. Wellington Ave., Melrose Park, Ill.
Ege, T., 314 W. 89 St., New York 24, N. Y.
Ellison, J. L., 1304 Ridge Ave., Wahiawa, Oahu, T. H.
Fegan, A. A., 17 W. Magnolia St., Stockton 3, Calif.
Feit, L., 4327 Bergenline Ave., Union City, N. J.
Fiet, J. H., III, 1206 Walnut St., Harrisburg, Pa.
Ferber, L. W., 5735 N. Seventh St., Philadelphia 20, Pa.
Feulner, F. A., 8633 109 St., Richmond Hill, L. I., N. Y.
Flynt, F. V., 7886 Vicksburg Ave., Los Angeles 45, Calif.
Follensbee, W. R., AAC DCS Comm. Office, APO 942, c/o PM, Seattle, Wash.
Freedman, W., 119 S. High St., Mt. Vernon, N. Y.
Fuller, G. R., 1807 AACS WATC, APO 207-1, c/o PM, New York, N. Y.
Gard, C. D., 132 San Nicolas Ave., Oxnard Beach P.O., Oxnard, Calif.
Gentry, W. E., 815 Peachtree St., N.E., Atlanta, Ga.
Graham, E., Jr., Box 310, Lebanon, Tenn.
Halvorsen, H. W., 3320 16 St., N.W., Washington 10, D. C.
Hamilton, R. E., 2308 20 St., Washington 9, D. C.
Hatfield, P. E., 752 Stewart Ave., Evansville, Ind.

(Continued on page 43A)

COSSOR for QUALITY

TWIN-BEAM

OSCILLOSCOPES

MODEL 1035 Provides *FAST SWEEPS*, from 150 Millisec. to 5 Microsec., and *Video Frequency* Amplifiers, Stepped -VE Feedback Type, with Gain of 3 at 7 Mc. Bandwidth to Gain of 3000 at 60 Kc. Bandwidth, ± 1.5 DB., *PLUS* Triggered Sweeps, Suppressed Flyback, ± VE Sync.

MODEL 1049 Provides *SLOW SWEEPS* from 1.5 Sec. to 50 Microsec., and *D.C. Amplifiers* Completely Stabilized Throughout, Response 0-100 Kc, ± 1.5 DB., Gain 900, PLUS Beam Blanking Circuits, Triggered Sweeps, ± VE Sync.

PLUS

Unique TWIN BEAM Flat Face CRT in *BOTH* Instruments Providing Instant Directly Calibrated Measurement for Accurate Voltage, Time and Phase Comparisons.

WRITE TODAY FOR LITERATURE AND DEMONSTRATION

COSSOR (CANADA) LIMITED
WINDSOR ST., HALIFAX, N.S.

BEAM INSTRUMENTS CORP.
Room 907, 511 Fifth Ave., New York 17, N.Y.

MEMBERSHIP

(Continued from page 42A)

Hathaway, W. L., R.D. 2, Box 408, Irving, Tex.
Hawkins, B. C., 1108 S. Cuyler Ave., Oak Park, Ill.
Heffner, R. W., 761 Summit Ave., Lake Forest, Ill.
Helm, R. J., 158 Bergen St., Newark 3, N. J.
Hill, B. M., 1081-2 Lakeshore Dr., Lake City, Minn.
Horton, M. C., 1107 N. Lawn Dr., Fort Wayne 2, Ind.
Hutcheson, J. H., 10878 National Blvd., Los Angeles 64, Calif.
Hynes, E. A., 6541 S. Lafayette Ave., Chicago 21, Ill.
James, J. N., 404 E. Foothill Blvd., Altadena, Calif.
Jimenez, A. B., Calle 65 #20-37, Bogota, Columbia
Jones, A. H., 105 Elmwood St., Emporium, Pa.
Jones, J., Box 100, R.D. 1, Clarks Summit, Pa.
Jones, M. G., 225 N. Washington Ave., Pierre, S. Dak
Kadetz, W., 4157 N. Clarendon Ave., Chicago 13, Ill.
Kennedy, K. R., 40 Main St., R. 9, Concord, N. C.
Koch, F. R., 719 Cedar St., Pacific Grove, Calif.
Koppels, P. N., 198–18 Jamaica Ave., Hollis, I. I., N. Y.
Krout, H. L., 625 S. Chestnut, Olathe, Kans.
Kuroye, K., 4056 N. California Ave., Chicago, Ill.
Labounty, J. E., 5 W. 63 St., New York 23, N. Y.
Larson, L. A., 1819 N. 53 St., Seattle, Wash.
Long, T. L., 339 Eighth St., N.E., Washington 2, D. C.
March, G. W., 1040 Third Ave., S.E., Cedar Rapids, Iowa.
Mayfield, J. D., 1514 First Ave., E., Cedar Rapids, Iowa
Mazzarella, M., 118 Foria, Naples, Italy.
McInnis, A. K., Jr., Box 3217, U.S.A.F.I.T., Wright-Patterson A.F.B., Dayton, Ohio
McLane, A. R., U. S. Navy Comm. Sta., c/o F.P.O., 1-4 Hdqrs. Naval Base, Pearl Harbor, Navy 128, San Francisco, Calif.
McTaggart, J. E., 113 Olive Ave., Willowdale, Ont., Canada
Merk, R. V. R., AAC DC-S Comm. Office, APO 942, c/o PM, Seattle, Wash.
Meslener, G. J., 516 E. 78 St., New York 21, N. Y.
Muller, F. P., 73 Tioga St., San Francisco 24, Calif.
Nash, R. W., R.D. 3, Binghamton, N. Y.
Nichols, A. H., 7926 Agnew Ave., Los Angeles 45, Calif
Noonan, J. A., 209 Washington Ave., Paintsville, Ky.
Noonan, J. T., 488-A Main St., Charlestown 29, Mass.
Olsen, R. F., 142 Camden St., Roselle Park, N. J.
Olszewski, L. V., 5205 N. Main St., Dayton, Ohio
Orr, W. S., Memphis Recording Service, 706 Union at Marshall, Memphis 3, Tenn.
Orr, B. B., 918 Buena Ave., Chicago 13, Ill.
Petit, A. H., 159 Aberdeen Ave., Dayton 9, Ohio
Pigache, N. L., A Balmuir Gardens, London S.W. 15, England
Powell, J. L., Jr., Bay St., Snow Hill, Md.
Radford, J. V., Box 371, 207 Spring St., Nederland, Tex.
Rice, J. E., 3631 R St., N.W., Washington 7, D. C.
Rodgers, L. D., Jr., Wellsville, Pa.
Rodriguez, E., Comercial Electrica, S.A., Sabinas, Coah., Mexico
Rosenblum, I. I., 4400 Kenwood Ave., Baltimore, Md.
Ryerson, J. L., 500 S. Rotherwood, Apt. 7a, Evansville, Ind.
Scanlan, J. A., 621 Roselle Ave., Hawthorne, Calif.
Schafer, W. W., 1036 S. Wesley St., Oak Park, Ill.
Schumacher, H., 33 Spring St., Chicopee, Mass.
Shaheen, M. R., 16 Dickinson St., Binghamton, N. Y
Shane, Z. G., 1026 Oakland St., Beaumont, Tex.
Shea, J. H., A.F.I.T., Wright-Patterson A.F.B., Box 3291, Dayton, Ohio
Shino, J. S., 506 Jarvis St., Toronto 5, Ont., Canada

(Continued on page 44A)

Which Of These Coil Forms Best Fits YOUR Needs?

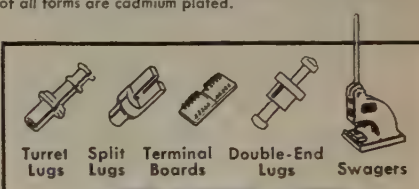
Coil Forms Only, Or Coils Wound To Your Specifications . . . Cambridge Thermionic will furnish slug tuned coil forms alone or wound with either single layer or pie type windings to fit your needs, in high, medium or low frequencies . . . and in small or large production quantities.

See table below for physical specifications of coil forms.

SEND COMPLETE SPECIFICATIONS FOR SPECIALLY WOUND COILS

Coil Form	Material	Mounting Stud Thread Size	Form O.D.	Mounted O.A. Height
LST	L–5 Ceramic	8–32	3/16"	19/32"
LS6	L–5 Ceramic	10–32*	1/4"	27/32"
LS5	L–5 Ceramic	1/4–28*	3/8"	1 1/16"
LSM	Paper Phenolic	8–32	1/4"	27/32"
LS3	Paper Phenolic	1/4–28	3/8"	1 1/8"
LS4†	Paper Phenolic	1/4–28	1/2"	2"

*These types *only* provided with spring locks for slugs.
†Fixed lugs. All others have adjustable ring terminals.
All ceramic forms are silicone impregnated. Mounting studs of all forms are cadmium plated.



Turret Lugs · Split Lugs · Terminal Boards · Double-End Lugs · Swagers

custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
456 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

MEASUREMENTS CORPORATION MODEL 80

STANDARD SIGNAL GENERATOR

2 to 400 MEGACYCLES

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

MODULATION: Amplitude modulation is continuously variable from 0 to 30%, indicated by a meter on the panel. An internal 400 or 1000 cycle audio oscillator is provided. Modulation may also be applied from an external source. Pulse modulation may be applied to the oscillator from an external source through a special connector. Pulses of 1 microsecond can be obtained at higher carrier frequencies.

FREQUENCY ACCURACY ±.5%

OUTPUT VOLTAGE 0.1 to 100,000 microvolts

OUTPUT IMPEDANCE 50 ohms

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

WIDE BAND DIRECT COUPLED OSCILLOSCOPE

Tektronix Type 514-D

Bandwidth: DC—10 mc

Sensitivity: AC—.03 v/cm
DC—.3 v/cm

Sweep Range: .01 μsec/cm—.01 sec/cm
continuously variable

Voltage Calibrator: Square wave,
0—50v in 6 ranges

The advantages of the direct coupled oscilloscope are now available in the region of 10 mc. Not only is it possible to measure the duration and amplitude of a waveform, but also the D.C. level at which it occurs.

- *Distributed type push-pull output amplifiers.*
- *All DC voltages electronically regulated.*
- *Triggered, recurrent or single sweeps.*
- *.25 μsec signal delay network.*
- *Better than 5% accuracy of timing and amplitude.*

Write or wire for complete specificatipns.

$950.00
f. o. b. Portland, Oregon

TEKTRONIX INC.
Cables, TEKTRONIX
712 S. E. HAWTHORNE BLVD. PORTLAND 14, OREGON

Membership

(Continued from page 43A)

Snow, J. E., MCLI Wright-Patterson A.F.B., Box 3303, Dayton, Ohio
Sprague, Z. E., 4631 Van Dyke Ave., San Diego 16, Calif.
Starkey, M. J., 1200—17 St., Manhattan Beach, Calif
Stetser, M. E., 223 Pennsylvania Rd., Brooklawn, N. J.
Stoll, J. L., 1214 N. Russett St., Portland 17, Ore.
Tass, M. H., 725 Wellesley Ave., Akron, Ohio
Wicks, C. E., Red Box 596, WGBS, Hialeah, Fla.
Willardson, F. W., 220 E. Sixth St. Ext., Emporium, Pa.
Wogan, R. S., 620 Lucas Dr., Xenia, Ohio
Wolinsky, A., 2344 Davidson Ave., New York 53, N. Y.
Woltz, R., Radar Dept., Hughes Aircraft Company, Culver City, Calif.
Wszolek, W., 3220 S. Morgan St., Chicago 8, Ill.

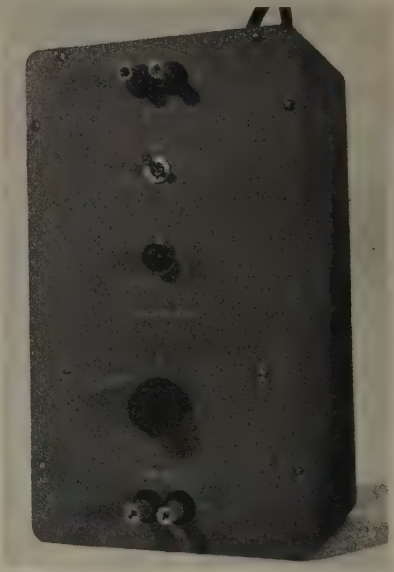
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 30A)

High-Impedance DC Millivoltmeter

Industrial Control Co., 1462 Undercliff Ave., New York 52, N. Y., has developed a new instrument, the Type 200-A dc millivoltmeter.



Characterized by a low internal residual, high input impedance, and gain stability comparable to that obtained in ac vacuum-tube voltmeters, the Model 200-A can detect dc voltages as low as 5 microvolts, or with suitable shunts, currents to a level of 10^{11} amps.

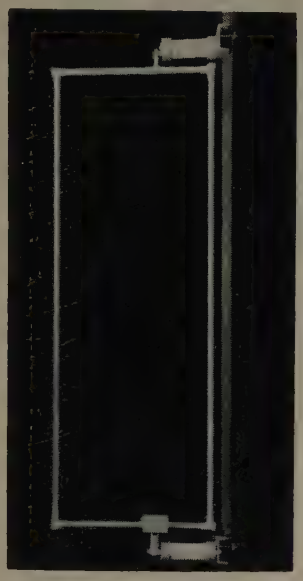
The output from the instrument is an ac voltage, the rms magnitude of which is precisely 1,000 times that of the dc input. The transfer gain is stabilized by the use of precision components and a strong local feedback loop.

There is no drift in the instrument. No zero set or balance controls, or calibration checks during measurement are necessary. A dynamic range of 10,000 to 1, and linearity of the output-input proportion are other advantageous features. An attenuator is provided at the input to extend the range of the unit up to 10 volts dc. The Model 200-A is operated from the 115 volt 60 cps line.

(Continued on page 45A)

3 New JOHNSON Sampling Loops

Now available, three newly designed models of JOHNSON Phase Sampling Loops covering all broadcasting sampling requirements and at sharply reduced prices.



For installations requiring high sensitivity and extreme stability, the 173-10 adjustable shielded loop (illustrated) is recommended. For less exacting applications and where economy is a major consideration, the new 173-11-1 and 173-11-2 unshielded loops are ideal.

The 173-10 shielded loop responds only to the magnetic field and provides high accuracy phase sampling, unaffected by weather conditions. The loop consists of two enamelled copper conductors securely supported and insulated from the 7/8" copper electrostatic shield tubing. Dimensions are: height 6 feet, width 2 feet. Heavy duty insulators support the loop which may be rotated and locked in position. Entry for the sampling line is provided in the bottom pivot shaft.

The unshielded loops offer an economical means of sampling tower currents where the use of the more sensitive electrostatically shielded loop is not warranted. The 173-11-2 is an insulated, adjustable single turn loop. The 173-11-1 loop is grounded to the tower and the tower member serves as the fourth side of the loop. Sensitivity is adjusted by varying the distance between the tower leg and the outer side of the loop. Construction is of heavily plated steel tubing and all necessary hardware for mounting and bonding is furnished Broadcast net prices of JOHNSON Sampling Loops are:

173-10	$65.00
173-11-1	30.00
173-11-2	40.00

For literature and technical data write:

JOHNSON
a famous name in Radio

E. F. JOHNSON CO. WASECA, MINN.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 44A)

New Miniature Insulated Terminals

Featuring small size combined with high dielectric properties, three new miniature insulated terminals have just been marketed by **Cambridge Thermionic Corp.**, 456 Concord Avenue, Cambridge 38, Mass.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals are available in three lengths of dielectric and with voltage breakdown ratings up to 5,800 volts.

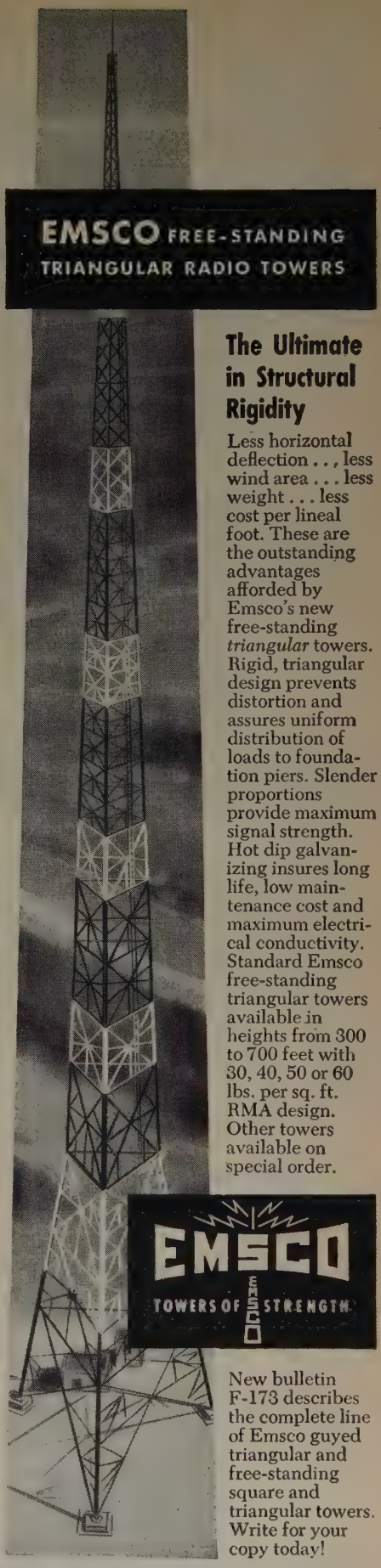
The X1980XA is the smallest terminal, having an over-all height of only 3/8 inch, including terminal. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

TV Wave-Form Monitor

A portable television wave-form monitor, Model TO-1, is now available from **Polarad Electronics Corp.**, 100 Metropolitan Ave., Brooklyn 11, N. Y.

This new wave-form monitor is a portable instrument designed for wave-form analysis, and amplitude measurement of video signals in television circuits. It may be used, however, as a general purpose instrument in many applications because of its wide-frequency response, high sensitivity, synchronizing capability, precision calibrating circuits, and large symmetrical horizontal expansion. Visual presentation is on a 5-inch cathode-ray tube.

(Continued on page 46A)



EMSCO FREE-STANDING TRIANGULAR RADIO TOWERS

The Ultimate in Structural Rigidity

Less horizontal deflection . . , less wind area . . . less weight . . . less cost per lineal foot. These are the outstanding advantages afforded by Emsco's new free-standing *triangular* towers. Rigid, triangular design prevents distortion and assures uniform distribution of loads to foundation piers. Slender proportions provide maximum signal strength. Hot dip galvanizing insures long life, low maintenance cost and maximum electrical conductivity. Standard Emsco free-standing triangular towers available in heights from 300 to 700 feet with 30, 40, 50 or 60 lbs. per sq. ft. RMA design. Other towers available on special order.

EMSCO
TOWERS OF STRENGTH

New bulletin F-173 describes the complete line of Emsco guyed triangular and free-standing square and triangular towers. Write for your copy today!

EMSCO DERRICK & EQUIPMENT CO.
Houston, Texas • Garland, Texas
LOS ANGELES, CALIFORNIA

AMPERITE

THERMOSTATIC METAL TYPE

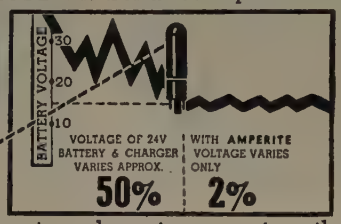
Delay Relays

PROVIDE DELAYS RANGING FROM 1 TO 120 SECONDS

FEATURES: — Compensated for ambient temperature changes from —40° to 110° F . . . Hermetically sealed; not affected by altitude, moisture or other climate changes . . . Explosion-proof . . . Octal radio base . . . Compact, light, rugged, inexpensive . . . Circuits available: SPST Normally Open; SPST Normally Closed.

PROBLEM? Send for *"Special Problem Sheet"*

Regulators



Amperite REGULATORS are the simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation . . . For currents of .060 to 6 Amps. . . . Hermetically sealed; not affected by altitude, ambient temperature, humidity.

Write for 4-page Illustrated Bulletin RE

AMPERITE CO., Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto

Ballantine WIDE BAND VOLTMETER

featuring the well-known BALLANTINE sensitivity, accuracy, logarithmic voltage scale and uniform DB scale

RANGE: 1 millivolt to 100 volts.
BANDWIDTH: 30 cycles to 5.5 MC.
INPUT IMPEDANCE: 1 megohm shunted by 9 mmfds.

Can also be used as a flat wide band amplifier having a max. gain of 52 DB.

Permanent accuracy and stability are insured by BALLANTINE pioneered circuitry and manufacturing integrity. For additional information on this voltmeter and other BALLANTINE voltmeters and accessories, write for catalogue 12-A.

Model 304. Price $225.

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U. S. A.

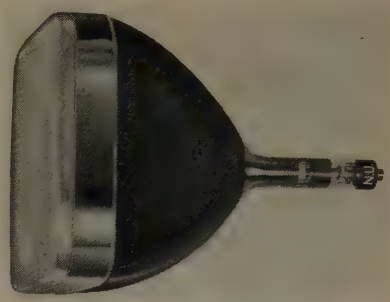
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 45A)

Two New Rectangular TV Tubes

Two new 16- and 14-inch rectangular tubes have been announced by **National Union Radio Corp.**, Orange, N. J.



The 16KP4 is a 65° direct-viewing tube providing a $10\frac{1}{8}$ inch $\times 13\frac{1}{2}$ inch rectangular picture having the standard 3×4 aspect ratio. It features a face plate having an integral neutral gray filter which increases the contrast ratio when viewing under ambient light conditions.

This tube utilizes the new tilted-beam-type gun to obtain improved picture detail. It requires only a single-field ion trap. The 16KP4 is identical to 16TP4, except for an increase in neck length to $7\frac{1}{8}$ inches which permits adaptability to a greater range of focus coil and deflection yoke designs.

The 14CP4 is a 65° direct-viewing picture tube providing an $8\frac{5}{8}\times11\frac{1}{2}$-inch rectangular picture. In other respects it is similar to the 16KP4 described above, having the $7\frac{1}{8}$-inch neck length for greater flexibility with respect to focus coil and deflection yoke designs.

Wheatstone-Megohm Bridge

A new Type 635-A, Wheatstone-megohm bridge, a versatile direct-reading instrument designed for resistance measurements between 10 ohms and 1,000,000 megohms has been designed and developed

by **Shallcross Mfg. Co.**, 520 Pusey Ave., Collingdale, Pa.

(Continued on page 47A)

THE
HI-GAIN Industrial
POCKETSCOPE®
BY WATERMAN

MODEL
S-14-A

Wt. 12¾ lbs.
12"x 5¾"x 7"

Another Waterman POCKETSCOPE providing the optimum in oscilloscope flexibility for analyses of low-level electrical impulses. Identified by its hi-sensitivity and incredible portability, S-14-A POCKETSCOPE now permits "on-the-spot" control, calibration and investigation of industrial electronic, medical and communications equipment. Direct coupling without peaking, used in the identical vertical and horizontal amplifiers, eliminates undesirable phase shifting. Designed for the engineer and constructed for rough handling, the HI-GAIN POCKETSCOPE serves as an invaluable precision tool for its owner.

Vertical and horizontal channels: 10mv rms/inch, with response within —2DB from DC to 200KC and pulse rise of 1.8μs. Non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude. Repetitive or trigger time base, with linearization from ½cps to 50KC with ± sync. or trigger. Trace expansion. Filter graph screen. Mu metal shield. And a host of other features.

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

WATERMAN PRODUCTS INCLUDE:

S-10-B GENERAL POCKETSCOPE
S-11-A INDUSTRIAL POCKETSCOPE
S-14-B WIDE-BAND POCKETSCOPE
S-15-A TWIN TUBE POCKETSCOPE
S-21-A LINEAR TIME BASE

Also RAKSCOPES, LINEAR AMPLIFIERS, RAYONIC® TUBES and other equipment

WATERMAN PRODUCTS

News—New Products

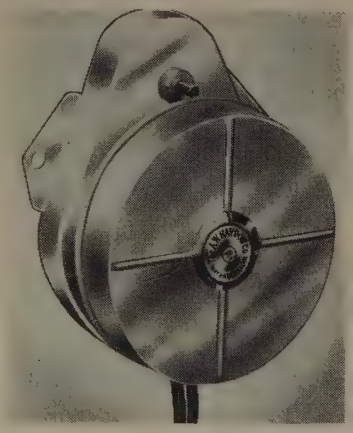
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 46A)

It can be used to measure resistance elements and insulation resistance and to determine the volume resistivity of various materials. The instrument is basically a Wheatstone bridge used in connection with a dc amplifier. Two built-in power supplies, operating on 115 volts, 60 cps, automatically provide the correct bridge voltages for the high and low ranges. A regulated supply is used on the high ranges to counteract the effects of dielectric absorption.

New Standardized AC Timing Motors

The **A. W. Haydon Co.**, 232 N. Elm St., Waterbury 20, Conn., announces a new line of standardized ac timing motors. These motors are of the synchronous hysteresis type and combine improved design and performance with lower cost.



Features of the new timing motors are the high starting and running torque and extremely quiet operation. They run at full synchronous speed over a wide range, despite variations as great as 25 per cent in line voltage. There is also a considerable range of speeds and current ratings.

Other facts include: slow speed rotor, shaded pole starting, capillary lubrication welded construction, and long life.

Motors fitting standard specifications are available immediately from stock, or complete timers incorporating these motors can be especially designed and supplied for volume requirements.

Replacement Cartridge

A new Model 60, replacement cartridge, which uses the Bimorph crystal and will replace over 20 other existing models, is now available from **Electro-Voice, Inc.**, Buchanan, Mich.

By inserting the appropriate 3-mil or 1-mil needle, it can be used for 78 rpm, or for 33⅓ and 45 rpm records. Tracking force is ¾ ounce on 78 rpm, and 8-grams on 33⅓ and 45 rpm; frequency response to 6,000 cps.

(Continued on page 48A)

Dependable PERFORMANCE at LOWER COST

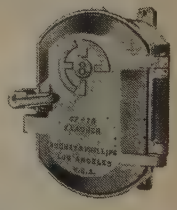
H&P TOWER LIGHTING EQUIPMENT

H & P lighting equipment, consistently specified by outstanding radio engineers, is furnished as standard equipment by most leading tower manufacturers.

300 MM CODE BEACON

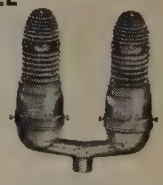
Patented ventilator dome circulates the air, assures cooler operation, longer lamp life. Concave base with drainage port at lowest point. Glass-to-glass color screen supports virtually eliminate color screen breakage. Neoprene gaskets throughout. CAA approved

MERCURY CODE FLASHER



Lifetime-lubricated ball bearings. No contact points to wear out. Highest quality bronze gears Adjustable, 14 to 52 flashes per minute

SINGLE and DOUBLE OBSTRUCTION LIGHTS



Designed for standard A-21 traffic signal lamps Prismatic globes meet CAA specifications.

"PECA" SERIES PHOTO-ELECTRIC CONTROL

Turns lights on at 35 f.c.; off at 58 f.c., as recommended by CAA. High-wattage industrial type resistors. Low-loss circuit insulation.

ALSO COMPLETE LIGHT KITS FOR A-2, A-3, A-4 and A-5 TOWERS

PROMPT SERVICE and DELIVERY

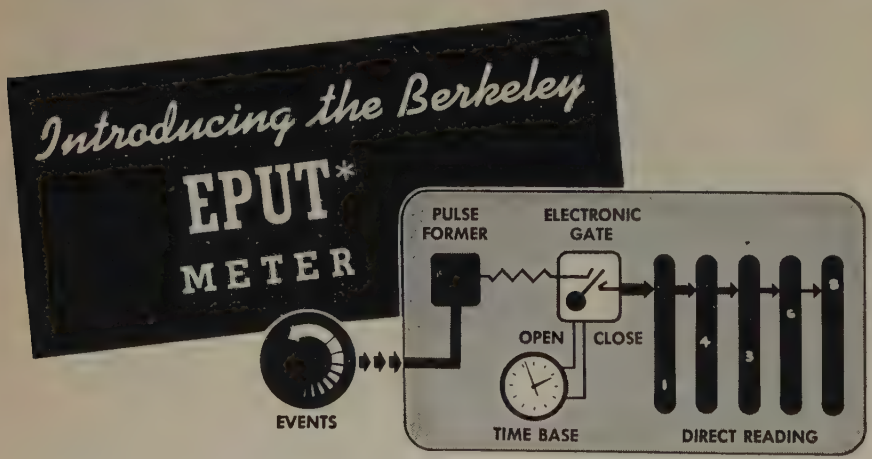
First-day shipments out of stock. Immediate attention to specifications and unusual requirements.

WRITE OR WIRE FOR CATALOG AND DETAILED INFORMATION

HUGHEY & PHILLIPS
TOWER LIGHTING DIVISION
326 N. LA CIENEGA BLVD.
LOS ANGELES 48, CALIF.
60 E. 42ND ST. NEW YORK 17, N. Y.

Examine the tubular and solid metal parts shown here twice size. If you use anything similar . . . in quantities of over a million . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,
Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.



NOW . . . determine Events-Per-Unit-Time* *automatically* with a single, compact direct-reading instrument!

Any physical, electrical or optical events of unknown occurrence rate that can be translated into changing voltages can be accurately counted during a precisely-measured time interval of one second. (Time base other than one second can be provided.)

In frequency measurements, for example, each cycle occurring during the accurately timed one-second interval is individually counted and the total displayed in direct-reading numerals on the illuminated front panel. Maximum counting rate is 100,000 per second; accuracy is ±1 event regardless of rate.

Send for bulletin IRE-750 for full, detailed description.

Berkeley Scientific Company
5IXTH AND NEVIN AVENUE • RICHMOND, CALIF.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 47A)

Output level depends upon the type of needle used. With compliant needle, the output voltage is 3½ volts. With straight shank needle, the output is 4½ to 5 volts. This extra high voltage output aids replacements in record players with low gain amplifiers and in single play phonographs.

The Model 60 has an E-V needle stop. This needle stop is mounted directly on the chuck and prevents it from rotating excessively and damaging the cartridge crystal, despite lateral pressure directed against the needle. The needle stop limits longitudinal motion of the chuck so that the crystal cannot be pulled from its harness.

New Snap-Action Switch

Comar Electric Co., 3148 N. Washtenaw Ave., Chicago 18, Ill., has announced a new snap-action switch for use in conjunction with relays, limit switches, and other applications.

According to the manufacturer, this switch is specially designed to take care of high inductive loads with a minimum of arcing, giving it a high ampere rating. For certain applications, the switch is adjustable to operating movement and overtravel. The main operating blade is made of tempered spring steel and can be furnished to operate at various pressures. Conventional switch can be used for single pole, single throw, or single pole, double throw requirements. Special types available on specification. Unit is compact in size and weighs about 1 ounce.

Five New Miniature Tubes

Five new types of miniature tubes, designed for dependability under conditions encountered in mobile and aircraft service, have been added to the product lines of **Tube Div., General Electric Co.**, Electronics Park, Syracuse, N. Y.

The heater construction of these types is designed to withstand many-thousand cycles of intermittent operation, tolerances are held to close specifications, and additional inspections and special tests are incorporated in production.

The 5749, a miniature remote cutoff pentode, is used as an rf and IF amplifier. The tube features low grid-plate capacitance and under typical operating conditions has a transconductance of 4,400 micromhos with a plate current of 11 ma.

(Continued on page 49A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

The 5750, a miniature pentagrid converter, is used as a combined oscillator and mixer in superheterodyne receivers. It features a conversion transconductance of 475 micromhos.

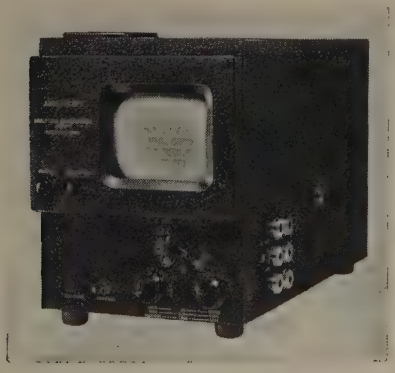
The 5725 is a miniature semiremote cutoff pentode. It is used in gated amplifiers, gain-controlled amplifiers, delay circuits, and mixer circuits. The main feature is the fact that the control grid and suppressor grid can be used as independent control elements

The 5726, a miniature twin diode, may be used as an AM-FM detector, automatic-volume-control rectifier, and low-current power rectifier. The tube features high perveance. Since the heaters for the two-diode sections are internally connected in a series, a heater failure makes both sections inoperative.

The 5686, a miniature pentode power amplifier, is used as a class-A audio power amplifier or class-C rf power amplifier up to 160 Mc. There are multiple leads on the cathode and screen grid which facilitate rf by-passing at high frequencies. A useful power output of 5.25 watts at 125 Mc or a class-A audio power output of 2.7 watts can be obtained.

New Versatile Measurement Equipment

The Analascope, a new instrument that provides a means for measuring and continuously showing any phenomena that can be translated into electrical impulses, is in production by **Analytical Measurements Inc.,** 585 Main St., Chatham, N. J.



Its possibilities as a tool of general utility in the laboratory can be appreciated from the fact that one moment it can serve as a pH meter which measures to 0.001 pH, and the next moment it can serve as an electrocardiograph, a pressure indicator, a strain analyzer, or, in fact an instrument for measuring any phenomena converted into electrical impulses, whether static, rapidly fluctuating, or of high or low impedance.

Results are displayed on the screen of a 5-inch cathode-ray tube which is an extremely flexible indicator. It allows continuous observation of nonrecurrent phe-

(Continued on page 54A)

D-C AMPLIFIER

0-1,000,000~
MODEL 36B

Stable, high gain, no overshoot on square waves. Equipped with illuminated dial meter and internal d-c calibrating voltage that permits use as sensitive d-c voltmeter. Shielded low-capacitance two-conductor input cable.

Voltage gain 10,000 to balanced output, 5,000 to unbalanced output. Either balanced or unbalanced input. Peak undistorted output of one watt in 6,000 ohms, or 220 volts into high impedance.

Electro-Mechanical Research, Inc.
RIDGEFIELD, CONNECTICUT

New Type 2A TAP SWITCHES
HAVE A CONSTANT CONTACT RESISTANCE OF
ONLY 1 or 2 MILLIOHMS!

These high quality switches with up to 24 contacts were specifically developed to meet the need for rugged precision instrument switches that have longer operating life and are economical components in competitively priced electronic instruments and military equipment.

Write for Technical Bulletin No. 28.

TECH LABORATORIES PALISADES PARK NEW JERSEY

ELECTRONIC ENGINEERS

AT

DuMONT TELEVISION

SENIOR ENGINEERS (5) B.S. in E.E.

1—Experienced VHF and UHF Equipment. Design and Propagation Measurement.

2—Experienced in Signal Circuits of AM, FM or TV Receivers.

3—Experienced in TV Deflection Circuits.

4—Experienced in Design of Wide Band IF and RF Amplifier Circuits applicable to VHF Equipment. Must have experience in use of Test Equipment and VHF Spectrum.

5.—Experienced in Television or other Electronic Development Work, Special Wave Form Generation, Synchronization and C.R.T. Deflection.

INTERMEDIATE ENGINEERS B.S. in E.E.

For positions No. 2 & 5 listed above

FOR TRANSMITTER DIVISION

2 years' experience, knowledge of Video Amplifiers, Counter Circuits, Cathode-ray & Indicators. Radar exp.

MECHANICAL ENGINEERS B.S. in M.E.

SENIOR & INTERMEDIATE

Experience in Mechanical Design and Specification of Radio, TV or Electronic Equipment. Preferably exp in Design of Mass Production.

Apply in person or write:

ALLEN B. DuMONT LABORATORIES, INC.
35 Market St.
East Paterson, N.J.

Att: M. Bruinooge, Personnel Dept.

Out-of-Town Interviews may be Arranged for Qualified Applicants

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

PHYSICISTS—SENIOR ELECTRONIC ENGINEERS

Familiar with ultra high frequency and microwave techniques. Experience with electronic digital and/or analog, computer research and development program. Salaries commensurate with experience and ability. Excellent opportunities for qualified personnel. Contact C. C. Jones, Personnel Dept., Goodyear Aircraft Corp., Akron 15, Ohio.

ASSISTANT TO CHIEF ENGINEER

Large specialty transformer manufacturer wants man experienced in small transformer work. Excellent opportunity for qualified man. Please state education and experience, also salary on last or present position. Southern Ohio location. All replies held strictly confidential. Suitable arrangements will be made to interview qualified applicants. Box 606.

TELEVISION ENGINEERS

Several engineers experienced in either technical or commercial phases of television are required in the formation of a new department. Send resume of qualifications to Personnel Dept., General Precision Laboratory, Inc., 63 Bedford Road, Pleasantville, N.Y.

PROFESSOR

Ph.D. or D.Sc. required. Age 40-45 with good teaching experience. Some industrial experience helpful. Large midwestern school, undergraduate and graduate program. State salary expected and qualifications. Box 609.

ELECTRONICS ENGINEER

Electronics engineer about 33 years old who preferably has had some graduate training and who his experienced in electronic circuit and apparatus design and development work. Wanted by a small but expanding and well known company specializing in precision electronic instruments. Located in New Jersey about 30 miles from New York City. Salary up to $7,000 plus bonus. Our employees know of this ad. Box 611.

ENGINEERS

Engineers and assistants needed at new Motorola laboratory in Phoenix, Arizona. Engineers are required to be graduates of accredited engineering school, specialists in VHF and UHF receiver design, microwave communication pulse circuits, VHF, UHF and microwave antenna design, etc. Assistants must be engineering graduate with electronic experience. Replies should be sent to Daniel E. Noble, 4545 Augusta Blvd., Chicago 51, Ill., stating education, experience and past salary schedules.

(Continued on page 51A)

Electronic Engineers

BENDIX RADIO DIVISION
Baltimore, Maryland
manufacturer of
RADIO AND RADAR EQUIPMENT
requires:

PROJECT ENGINEERS
Five or more years experience in the design and development, for production, of major components in radio and radar equipment.

ASSISTANT PROJECT ENGINEERS
Two or more years experience in the development, for production, of components in radio and radar equipment. Capable of designing components under supervision of project engineer.

Well equipped laboratories in modern radio plant . . . Excellent opportunity . . . advancement on individual merit.

Baltimore Has Adequate Housing

Arrangements will be made to contact personally all applicants who submit satisfactory resumes. Send resume to Mr. John Siena:

BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION
Baltimore 4, Maryland

Senior Electronic Circuit Physicists

for advanced Research and Development

Minimum Requirements:

1. **M.S. or Ph.D. in Physics or E.E.**
2. **Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.**
3. **Minimum age 28 years.**

RESEARCH AND DEVELOPMENT LABORATORIES
Hughes Aircraft Company
Culver City, California

POSITIONS OPEN

(Continued from page 50A)

TELEVISION ENGINEERS

Television engineers with at least 3 years design experience, preferably electrical engineering, as production engineer for nationally known radio and TV manufacturer located in Upper New York state. Box 612.

ANTENNA ENGINEER

Long Island laboratory has an opening that is unusually suitable for an engineer who prefers a small company, is interested in specializing in VHF and microwave antennas and who has carried real responsibility in this or a closely related field. Box 614.

ACOUSTIC ENGINEER

For research and design on loudspeakers and microphones. Must have a thorough background in acoustics, audio and measuring technics, with a minimum of 5 years laboratory or practical design experience on loudspeakers or transducers. Progressive manufacturer located in New York suburban area. Send complete resume and state salary requirements. Box 415.

RADIO ENGINEER

Electrical or radio engineer: must have development experience in audio frequency circuit design. Acoustical experience also helpful. State experience, age, salary desired. Box No. 616.

ELECTRONIC ENGINEER

At least 5 years post-college experience development D.C. amplifier, digital computers, pulse and servo design. Established company, classified work, New York City. Box 617.

PROFESSOR

Professor of communications engineering needed for fall 1950 by southeastern university. Will be in charge of graduate work and research activities. $6,500.00 for nine months with extra income for summer teaching, or sponsored research. Must have Ph.D. or D.Sc. degree. Write Box 618.

JR. ELECTRICAL ENGINEER

Attractive opportunity for junior electrical engineer with manufacturer of uhf equipment. Preferably a man with one or two years experience. Reply to Box 619.

Positions available for

SENIOR ELECTRONIC ENGINEERS

with

Development & Design Experience

in

MICROWAVE RECEIVERS
PULSED CIRCUITS
SONAR EQUIPMENTS
MICROWAVE COMMUNICATIONS SYSTEMS

Opportunity For Advancement Limited only by Individual Ability

Send complete Resume to:
Personnel Department

MELPAR, INC.
452 Swann Ave.
Alexandria, Virginia

RCA VICTOR
Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

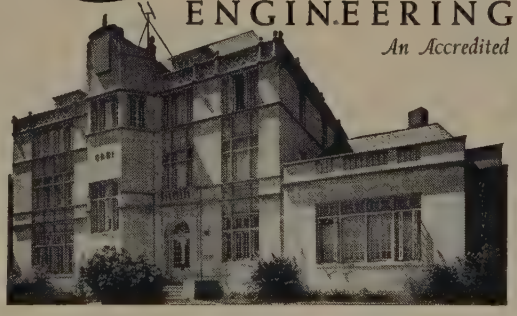
If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 750, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO
ENGINEERING INSTITUTE

An Accredited Technical Institute



ADVANCED HOME STUDY AND RESIDENCE COURSES IN PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING

Request your free home study or resident school catalog by writing to:

DEPT. 267B
16th and PARK ROAD, N.W.,
WASHINGTON 10, D.C.

Approved for Veteran Training

RADAR
ENGINEER-PHYSICIST WANTED

Must have heavy experience in basic study and research on new radar equipment.

also: **COMPUTER-DEVELOPMENT ENGINEER**

Must have heavy experience in basic study development and prototype construction of analog computers.

Excellent opportunity for Senior Men. Juniors please do not apply. State full particulars.

Replies confidential

Write: A. Hoffsommer

The W. L. MAXSON Corporation
460 W. 34th Street **New York 1, N.Y.**

PHYSICISTS AND ENGINEERS

This established but expanding scientist-operated organization offers excellent opportunities for a future in completely new fields to alert, experienced physicists and engineers. For example, some appointees will work on advanced versions of JAINCOMP (this company's ultra high speed, ultra compact digital computer and controller). Men with sound backgrounds and experience in the design of advanced electronic circuits, computers, or precision mechanical instruments, or with experience in applied physics are offered the opportunity to qualify for key positions. This company specializes in research and development work; its well-equipped laboratories are located in a pleasant residential suburb of Washington, D.C.

JACOBS
INSTRUMENT CO.
4718 Bethesda Ave.
Bethesda 14, Maryland

PROCEEDINGS OF THE —1949— NATIONAL ELECTRONICS CONFERENCE

—CHICAGO—

Now Available

60 Papers on Electronics research and development in this 575-page *cloth-bound* volume just off the press.

Mail Your Coupon Now To Obtain Your Copy of This Limited Edition.

NATIONAL ELECTRONICS CONFERENCE, INC.
852 East 83rd St. Dept. 1R7
Chicago 19, Illinois

I inclose $4.00 (check or money order) for which please send me one (1) copy of the Proceedings of the 1949 National Electronics Conference.

Name .....
Street Address .....
City..... Zone.... State.....

(Proceedings of previous conferences available upon request)

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

COMMUNICATIONS ENGINEER

B.S.E.E. West Virginia University, August 1949. Eta Kappa Nu, Sigma Pi Sigma. Age 24. Married. 2 years AAF Radio Maintenance. Desires communications or electronic work anywhere in U.S. Box 395 W.

COMMUNICATIONS ENGINEER

A.B. cum laude, M.S.E.E., Dartmouth College. Married, age 27. Experience: 1½ years equipment design, ionosphere research project, 4 years as trainee in Signal Corps, instructor, technical writer, project officer — communications equipment, 8 years organizer and director of choral and orchestral groups. Desires position in which engineering and musical training are valuable—radio work, high fidelity equipment design and development. Box 415 W.

ELECTRONIC ENGINEER

B.B.A. Sept. 1948, City College of N.Y., B.S.E.E. Cum laude Jan. 1950. M.S. physics, June 1950, University of New Hampshire. Pi Mu Epsilon. Phi Kappa Phi. Married. Age 27. 3 years training and experience as radar officer in Anti-Aircraft Artillery. Desires work in production and quality control of electronic equipment. Box 416 W.

PHYSICIST

Ph.D. in physics, University of Texas, June 1950. Age 30, married. Several years experience in microwave work. Also Army radar officer. Desires position in southwest, teaching and/or research. Box 417 W.

SERVO ENGINEER

M.S.E.E. servomechanisms major, Ohio State University, June 1950; B.S.E.E. University of Wisconsin 1944. Age 27. Married. 3 years experience in research and development of small electromechanical systems plus 2 years Navy electronics. Box 418 W.

PHYSICIST

B.S. physics, Feb. 1950, Columbia University. Age 23. 23 months Naval electronics, 3 months Student Aide physicist, radone design. Desires work in applied physics with opportunity for graduate work. Single. New York area preferred. Box 419 W.

(Continued on page 53A)

IT'S DU MONT FOR OSCILLOGRAPHY

Du Mont offers a complete line of cathode-ray oscillographs and associated equipment. For complete information and literature write to

ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
1000 Main Ave., Clifton, N.J.

PROJECT ENGINEERS

Real opportunities exist for Graduate Engineers with design and development experience in any of the following: Servomechanisms, radar, microwave techniques, microwave antenna design, communications equipment, electron optics, pulse transformers, fractional h.p. motors.

SEND COMPLETE RESUME TO EMPLOYMENT OFFICE.

SPERRY
GYROSCOPE CO.
DIVISION OF
THE SPERRY CORP.
GREAT NECK, LONG ISLAND

Centralab
ERL
Division of GLOBE-UNION INC.
Milwaukee

The
First Name
in
Ceramic
Electronic
Components

ARNOLD
Permanent Magnets

100% Quality Controlled in every Physical Magnetic and Metallurgical Characteristics.

You can save production time and material cost, and improve performance with Arnold Permanent Magnets. Supplied in all Alnico grades and other magnetic materials, in cast or sintered forms, and in any size, shape or degree of finish required. Engineering consultation quickly and freely available at your request.

The Arnold Engineering Co.
Subsidiary of
ALLEGHENY LUDLUM STEEL CORPORATION
Marengo, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

Positions Wanted

(Continued from page 52A)

ELECTRONIC ENGINEER

B.E.E. October 1948. 8 months experience trouble-shooting IBM machines; 6 months radio repair school in Signal Corps. Desires position in south or mid-west in development work of transformers, electronics or power. Available March 1950. Box 420 W.

ELECTRO-MECHANICAL ENGINEER

B.Aero.E. 1948, B.E.E. 1950. 2 years Navy and industrial electronic technician. 1 year M.E. development, servo-controlled aircraft radar. Some E.E. work on instruments and dielectric heating. Desires servo, instrument, TV or technical writing position. New York City area. Box 421 W.

JUNIOR ELECTRONIC ENGINEER

B.S.E.E. June 1950, University of Connecticut. Age 26. Married, 1 child. 27 months as Navy electronic technician, plus other experience. Prefer design, development, research in communication field. Will relocate anywhere. Resume upon request. Box 423 W.

JUNIOR ELECTRICAL ENGINEER

B.E. (E.E. major) February 1950, University of Toledo. Married. Age 29. Graduate of Navy radar, gyro and interior communications schools. Desires electronic work anywhere in U.S. Box 424 W.

BUSINESS ADMINISTRATION—ENGINEER

B.S. Business Administration, major accounting, Wayne University, June 1949, age 27, married. Broad background in radio communications. Desires employment in accounting department of electronics or communications anywhere in U.S. where knowledge of electronics and accounting can be combined. Commercial and amateur licenses. Experience with airborne radio and high-power radio teletype equipment. Box 426 W.

ENGINEER

B.S.E.E. Columbia, June 1950. Age 27, single. 3 years experience as radio technician, building, operating and repairing electronic equipment and assisting in application engineering projects. Work preference: application engineering. Metropolitan New York location preferred. Box 427 W.

ELECTRONIC-CHEMICAL ENGINEER

Electronic-chemical engineer, age 27. B.S. in Chemical Engineering and in E.E. 1949. M.S. in E.E. January 1950, University of Wisconsin. Some Signal Corps radio school experience. Single. Will locate anywhere. Box 428 W.

ELECTRONIC ENGINEER

Electronic engineer. Age 41. 7 years college; 15 years responsible practical experience in electronic operation, design and research. Now employed as consultant on job which will be completed this fall. Desires responsible position, credentials forwarded upon request. Salary open. Address: American, 72 Mococa, Sao Paulo, Brazil.

ENGINEER

Assistant professor, radio communications, electronics. College graduate, L.L.B. degree. At present, International broadcast engineer overseas and Naval reserve officer, radio instructor. Experience includes consulting engineering, research

(Continued on page 53A)

ELECTRONICALLY REGULATED
LABORATORY
POWER SUPPLIES

BENCH
MODEL 25

• STABLE
• DEPENDABLE
• MODERATELY PRICED
•

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

WIDTH 14"
DEPTH 6"
HEIGHT 8"
WT: 17 LBS.

For complete information write for Bulletin G

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

FOR *Critical* TAPE RECORDING
to 40,000 cycles

Tape recording is superior to all other reproduction methods and "AMPEXED TAPE" has the greatest fidelity and range now possible. Simplified operation plus sure results make AMPEX unexcelled for all critical recording uses. Dual tape speeds with automatic speed and equalization change is but one of many exclusive AMPEX features. *Unequalled for*

TELEMETERING • BROADCASTING • RESEARCH

AMPEX STANDARD OF THE GREAT RADIO SHOWS

Simultaneous
• ERASE
• RECORD
• PLAY BACK
MODEL 300
Price $1575
(f.o.b. San Carlos)
Meter Control
Panel $114 Extra

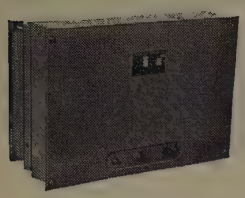
AMPEX ELECTRIC CORP., San Carlos, California
Without obligation please send 16-page illustrated booklet containing technical specifications of Ampex Magnetic Tape Recorders. AX 18

NAME_____
ADDRESS_____
CITY_____ STATE_____

Our need is for:
☐ Laboratory Research ☐ Telemetering
☐ Multi-Channel Recording ☐ Industrial Recording
☐ Recording-Broadcasting ☐ Aerophysical Research

AMPEX ELECTRIC CORPORATION
SAN CARLOS, CALIFORNIA
DEALERS IN PRINCIPAL CITIES

the first line of STANDARD electronic voltage regulators



Sorensen electronic voltage regulators offer accuracy under simultaneous line and load changes.

IMPORTANT SORENSEN FEATURES:

1. Precise regulation accuracy;
2. Excellent wave form;
3. Output regulation over wide input voltage range;
4. Fast recovery time;
5. Adjustable output voltage, that once set, remains constant;
6. Insensitivity to line frequency fluctuations between 50 and 60 cycles.

The Sorensen Catalog contains complete specifications on standard voltage regulators and nobatrons. It will be sent to you upon request.

SORENSEN & Company, Inc.

375 Fairfield Ave., Stamford, Conn.

Positions Wanted

(Continued from page 53A)

and development, N.B.S. broadcast stations and 6 years teaching radio. Box 388 W.

INSTRUCTOR

B.S. and M.S. in E.E. Desires teaching position in electrical engineering. Available September 1950. Member Phi Kappa Phi, Eta Kappa Nu, Tau Beta Pi. 1 year teaching experience as full time instructor. Age 24. Married. Box 442 W.

ELECTRONIC ENGINEER

B.S. in physics, June 1950, John Carroll University. Age 23. Single. 1 year experience as Navy radio technician and 6 years radio repair part time. Desires position in development or research. Box 443 W.

JUNIOR ENGINEER

B.S.E.E. June 1950, New York University. Desires position preferably in electronics or communication fields. 3 years Army experience as aircraft mechanic with some work on radar equipment installation and maintenance. Age 29, married, one child. Box 444 W.

COMMUNICATIONS TEACHER

Assistant Professor in electrical engineering department of southern university desires similar position in east or north, teaching electronics and communications principles. B.S., M.A., M.S.E.E. (1948), University of Illinois. 4 years' teaching Signal Corps schools. 8 months research on electronic timing. Age 30, married, 2 children. Eta Kappa Nu, Sigma Xi. Box 445 W.

Positions Wanted

ELECTRICAL ENGINEER

B.S.E.E. June 1950, Newark College of Engineering. Age 23. Former Navy electronics technician. Desires position in research, design or development in communications field of electronics. Tau Beta Pi. Resume upon request. Will relocate but east coast preferred. Box 446 W.

LIAISON ENGINEER

Age 31, qualified to establish liaison group for coordinating production and design. B.S.E.E. (Night School), 3½ years on development of PTM systems, 2½ years electronic piece part production, 2½ years systems installation and engineering, 2 years 1st class wireman and mechanic, 20 months as RTIC in Navy. Box 447 W.

ELECTRONIC ENGINEER

Electronic engineer, graduated M.I.T. 1943 with B.S. and M.S. degrees, specializing in pulse communications systems. Desires permanent position. Box 448 W.

ELECTRICAL ENGINEER

B.S.E.E. June 1950, Newark College of Engineering, Top 10%. Tau Beta Pi. Navy ETM; Reserve AETM. Age 23. Single. Summer experience wiring and drafting. Well qualified for position in development of electronic equipment. Box 449 W.

JUNIOR ENGINEER

B.E.E. Cooper Union, majored in electronics, graduated June 1950. Military service work on automatic pilots, amplifiers, gyros, etc. for 1 year. Also 1 year of work on aircraft transmitters and receivers as technician. Amateur Radio Class A license for past 6 years. Desires position in electronics or electro-mechanical field. Age 24. Box 450 W.

ELECTRICAL ENGINEER

Recent graduate of leading Canadian university. B.Sc.E.E. 5 years as radar technician in Air Force. Practical electrical background. Married, veteran. Interested in production or sales. Location secondary. Available immediately. Box 451 W.

Only with CO-AX air-spaced articulated R.F. CABLES

THE LOWEST EVER CAPACITANCE OR ATTENUATION

We are specially organised to give SPOT DELIVERIES TO U.S.A

Cable your rush order for shipment by air freight. Settlement by your own $ check

LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft of 100 Mc/s.	LOADING Kw Mc/s.	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	
A 34	73	0.6	1.5	0.88	HIGH POWER FLEXIBLE
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100 Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	V.L.C. ★
C44	4.1	252	2.1	1.03	

★ *Very Low Capacitance cable.*

TRANSRADIO LTD

CONTRACTORS TO H.M. GOVERNMENT

138A CROMWELL ROAD·LONDON SW7 ENGLAND

CABLES: TRANSRAD. LONDON.

News—New Products

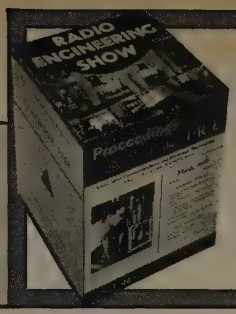
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 49A)

nomena at sweep speeds of from 0.01 to 5 seconds. A two decade precision potentiometer calibrated with the self-contained standard cell provides direct measurements from 0.001 pH to 15 pH and 0.1 mv to 1.5 volts. An input attenuator of 1,000 megohms provides overlapping ranges of 1 μμa to 10 ma and 1 mv to 100 volts per centimeter deflection.

(Continued on page 63A)

TO SELL THE RADIO INDUSTRY



Proceedings of the I.R.E.
Monthly Publication of the
INSTITUTE OF RADIO ENGINEERS
WILLIAM C. COPP — *National Advertising Manager*
303 WEST 42nd STREET, NEW YORK 18, N. Y.
Circle 6-6357

TELL THE RADIO ENGINEERS

Announcing-

The 1951 Radio Engineering Show

"Advance with Radio-Electronics" will be the theme of the 1951 IRE National Convention, to be held in New York City:

March 19-22

at The Waldorf-Astoria Hotel, and Grand Central Palace.

Exhibit space is now being offered for manufacturers who wish to show engineers the new "Advances" they have contributed to this growing industry.

17,689 fully classified visitors attended the 1950 sessions and Radio Engineering Show, to see what 253 exhibitors "spotlighted" as new and progressive. Into these four days have been concentrated a big convention in which the show is recognized as the world's most effective meeting place for engineer with manufacturer.

A detailed analysis of this audience, in five, fast-reading summary charts is available to prospective exhibitors on request. The completeness of this attendance report answers every question as to how good a market this Radio Engineering Show audience is.

Full exhibit floor plans are shown on the following pages. This will be IRE's largest show, with increased space on the lecture-hall floor (third). The two halls have been moved and improved both in size and visibility.

A complete Audio Centre is provided with seven sound demonstration theatres, as well as open booths. Sound must necessarily be restricted on the open floor. Other special features are a number of "island" units, spacious courts on the first and second floors, the Nuclear Centre, and wide aisles everywhere to speed traffic flow to every booth.

Naturally, past exhibitors have been given "first choice" on renewing their previous positions, but the show is *now open to new firms,* and space is available to the prompt!

The Radio Engineering Show brings out the engineering-applications side of radio "advances" *for the service of members,* and gives the manufacturer a priceless opportunity to meet engineers, face-to-face.

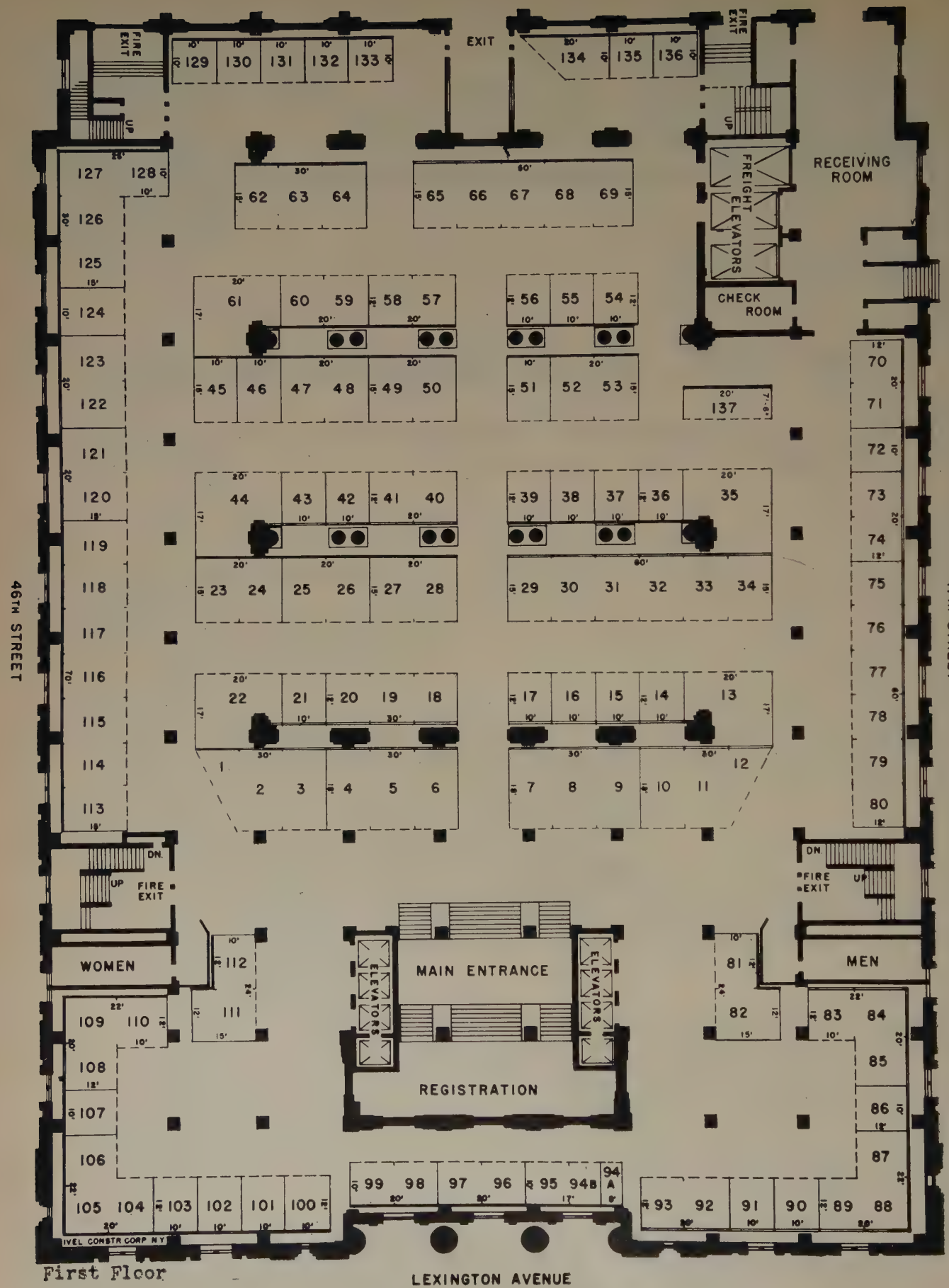


Exhibit Floor Plan of the 1951 Radio Engineering Show

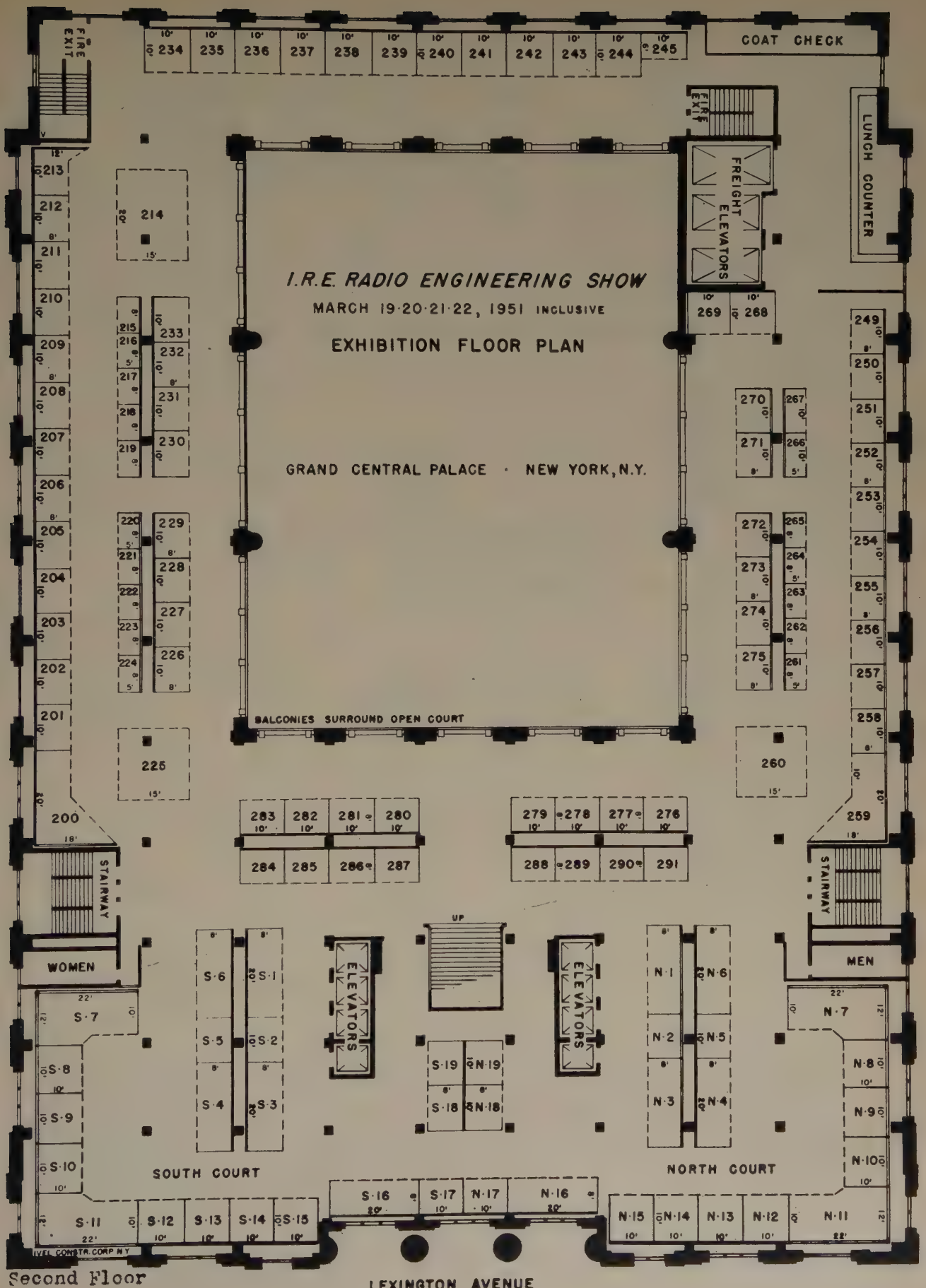


Exhibit Floor Plan of the 1951 Radio Engineering Show

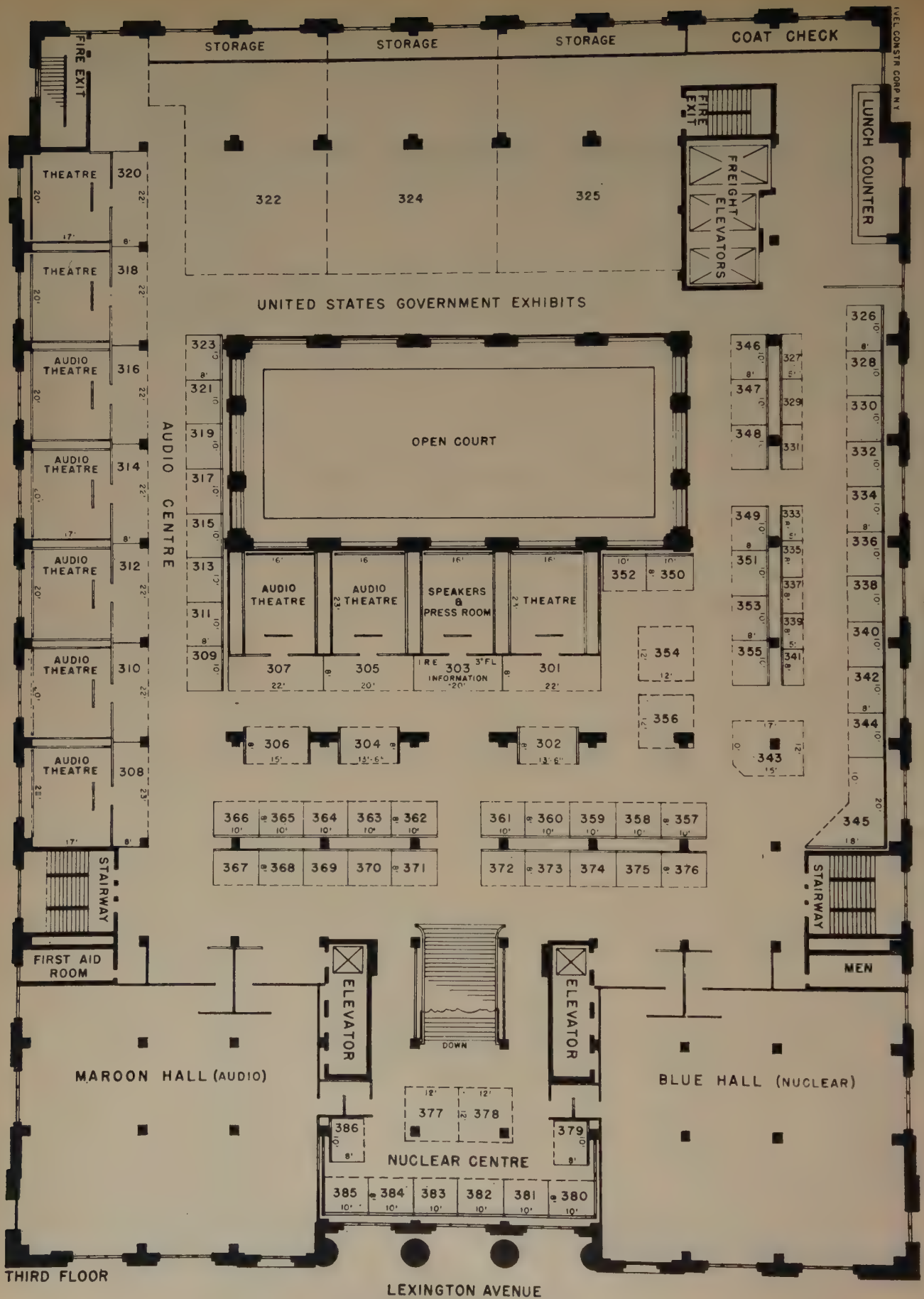


Exhibit Floor Plan of the 1951 Radio Engineering Show

For Reliability, I use OHMITE

BROWN DEVIL RESISTORS

Sturdy, wire-wound, vitreous-enameled resistors for voltage dropping, bias units, bleeders, etc. In 5, 10, and 20-watts; values to 100,000 ohms.

FIXED RESISTORS

Resistance wire is wound over a ceramic core, permanently locked in place, insulated and protected by Ohmite vitreous enamel. In 25, 50, 100, 160, and 200-watt stock sizes; values from 1 to 250,000 ohms.

DIVIDOHM RESISTORS

You can quickly adjust these handy vitreous-enameled resistors to the exact resistance you want, or put on taps wherever needed for multi-tap resistors and voltage dividers. In sizes from 10 to 200 watts, to 100,000 ohms.

LITTLE DEVIL* COMPOSITION RESISTORS

Tiny, molded, fixed resistors—individually marked with resistance and wattage rating—½, 1, and 2-watt sizes, ±10% tol. Also ±5% tol. 10 Ohms to 22 megohms.

DUMMY ANTENNA RESISTORS

For loading transmitters or other r.f. sources. New, rugged, vitreous-enameled units are practically non-reactive within their recommended frequency range. 100 And 250-watt sizes, 52 to 600 ohms, ±5%.

MOLDED* COMPOSITION POTENTIOMETER

A high-quality, 2-watt unit with a good margin of safety. Resistance element is solid molded—not a film. The noise level is low and decreases with use.

CLOSE CONTROL RHEOSTATS

Insure permanently smooth, close control. Widely used in industry. All ceramic, vitreous enameled; 25, 50, 75, 100, 150, 225, 300, 500, 750, and 1000-watt sizes.

DIRECTION INDICATOR POTENTIOMETER

Compact, low cost. Used in a simple potentiometer circuit as a transmitting element to remotely indicate the position of a rotary-beam antenna.

HIGH-CURRENT TAP SWITCHES

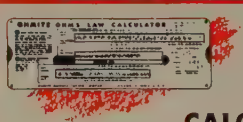
Compact, all-ceramic, multipoint, rotary selectors for a-c use. Self-cleaning, silver-to-silver contacts. Rated at 10, 15, 25, 50, and 100 amperes. Two or more can be mounted in tandem.

POWER LINE CHOKES

Keep r.f. currents from going out over the power line and causing interference with radio receivers. Also used to stop incoming r.f. interference. Has a ceramic core and moistureproof coating. In 5, 10, and 20 amps.

RADIO FREQUENCY CHOKES

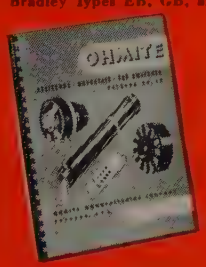
Single-layer wound on low power-factor steatite or bakelite cores, with moistureproof coating. Seven stock sizes for all frequencies, 3 to 520 mc. Two units rated 600 ma, others rated 1000 ma.



NEW OHM'S LAW CALCULATOR

Redesigned! Figures all Ohm's Law problems, including parallel resistance, with one setting of the slide. Also has standard slide rule scale. Send 25c in coin.

*So that these two exceptionally high-quality products will be universally obtainable, Ohmite Manufacturing Company, in co-operation with the Allen-Bradley Company, has arranged for the Type AB (Allen-Bradley Type J) control and Little Devil Molded Composition Resistors (Allen-Bradley Types EB, GB, and HB) to be available from stock at Ohmite distributors.



SEND FOR CATALOG NO. 40
on Company Letterhead
Provides 96 pages of engineering information

OHMITE MANUFACTURING CO.
4861 Flournoy St. Chicago 44, Ill.

Be Right with OHMITE
Reg. U. S. Pat. Off.

NEWS and NEW PRODUCTS

AUGUST, 1950

New Communications Recorder

Known as the Audiolog, a new recording unit especially designed for logging and monitoring radio and phone communications has been announced by **Audiolog Corp.**, 440 Peralta Ave., San Leandro, Calif.

An important feature of the unit is the use of a thin, flexible, reusable sleeve or tube of magnetic material upon which an entire hour of speech or code communications can be recorded. The use of the sleeve eliminates the usual spooling and reeling. The flexible sleeves can be "telescoped" so that a 24-hour log can be filed as a compact unit. The reusable sleeves do not deteriorate with repeated playbacks, and tests indicate they will retain the recording indefinitely.

The magnetic recording sleeve is slipped over the internally-driven rotating drum on the Audiolog instrument, and is held in, position by a quick-release tension bar which permits easy sleeve changing. Separate recording and playback heads move longitudinally across the drum, so arranged that any recorded portion may be played back while recording is in progress. Recording and playback heads are equipped with inexpensive polepieces, which can be quickly replaced like phonograph needles when worn. An advance magnet on the recording head automatically "erases" previously recorded material when re-using old sleeves.

The recorders are available in either portable or rack-mounted stationary units in single or dual type. The dual-recorder unit has automatic changeover. A small portable unit, using 30 minute recording sleeves, is also available.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Bolometer Amplifier

Pickard & Burns, Inc., 240 Highland Ave., Needham 94, Mass., Model 100 Bolometer amplifier is a high-quality portable instrument designed for use in testing antenna systems or other rf networks.

The amplifier features a tunable bandpass filter covering the frequency range of 400- to 5,000-cps, with bandwidths of 6 to 300 cps. It provides for automatic normalization of input signals and for accurately expanding input voltages to facilitate measuring standing-wave ratios in well-matched systems. A 100-db input voltage range is metered, while an undecaded output voltage range of 80 db is available for automatic recording equipments. The input circuits are designed for either crystal or bolometer probes. Amplification is linear to ± 1 per cent with a minimum useful input of 0.1 microvolt.

Description—The Model 100 is a heterodyne type of amplifier in which input signals to both the signal and monitor inputs are heterodyned to a 50-kc intermediate frequency. Signals at the 50-kc intermediate frequency are then passed through a crystal filter, amplified, and metered. Voltage to the recorder output is obtained by reconverting the 50-kc signal to the original input frequency.

Magnetic and electrostatic shielding permits the amplifier to function under usual laboratory and field conditions without interference from other equipments.

This equipment was originally developed in co-operation with the Office of Naval Research on specifications prepared by the Antenna Instrumentation Sub-Panel R.D.B. and the Test Equipment Subcommittee of A.R.E.C. It is now available to the industry and is described in detail in Bulletin L-110, obtainable from the manufacturer.

Printed Circuit TV Tuner

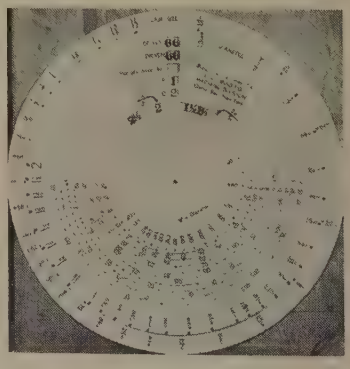
A new "Dynamic Tuner," using a rotating turret with the tuning assembly for each TV channel placed in 12 different sections around its periphery, is being produced by **The Hallicrafters Co.**, 4401 W. Fifth Ave., Chicago 24, Ill. As the turret is turned by the channel selector knob, the proper tuning assembly is moved into position.

The tuning coils for each channel, instead of being wound with wire, are photographically printed on a single strip of plastic, measuring only about $\frac{5}{8}$ inch wide and $4\frac{1}{8}$ inches long.

The uniformity and accuracy of the printed coil strips may be seen from the way in which the strips are prepared. The process is begun with a large thin sheet of copper bonded to a sheet of phenolic plastic. Then the copper is coated with a light-sensitive enamel and a photographic print made, leaving many patterns of the desired circuit on the copper. The sheet is then placed in an acid bath and the parts not covered by the enamel are etched completely away. What remains are the many printed circuits, each having precisely the same shape and thickness of copper. The individual strips are then cut off the large sheet, thus producing many sets of coils with identical electronic characteristics.

Rotary Slide Rule for Coil Winding Computation

A gear computer for universal coil winding has been developed by **Production Equipment Co.**, 37 W. Main St., Oyster Bay 9, L. I., N. Y. This rule gives complete data regarding number of crossovers, q (number of crossovers in one winding cycle), and selection of idler gears to provide the required gain for all wire, cam, and coil sizes.



Coil engineers interested in production and design of universal windings will find this rotary slide rule of priceless value in saving time and in improving coil structure.

(Continued on page 48A)

SECTION MEETINGS

ATLANTA

"The Brain and Electronics," by L. H. Montgomery, Chief Transmitter Engineer, WSM; May 26, 1950.

BEAUMONT-PORT ARTHUR

"Some Problems in Miniaturization of Component Parts," by Leon Podolsky, Sprague Electric Company; May 17, 1950.

"Electrons at Work and Play," by R. L. Nichols, Magnolia Petroleum Co.; May 30, 1950.

"TV Capacitors," by John Leedom, Sprague Electric Co.: June 5, 1950.

BOSTON

"Television—Why the Deep Freeze?" by S. L. Bailey, Jansky and Bailey; January 26, 1950.

"A 3,000-Mc Bandwidth Amplifier Triode," by L. F. Moose, Bell Telephone Laboratories; February 23, 1950.

"The RCA-NBC UHF Television Project at Bridgeport, Conn.," by R. F. Guy, National Broadcasting Company; "1-KW UHF Television Transmitter," by T. M. Gluyas, RCA Victor; "UHF Television Antenna System," by O. O. Fiet, RCA Victor; Election of Officers; May 25, 1950.

BUFFALO-NIAGARA

"Industrial Television System," N. S. Bean, RCA Victor; Election of Officers; May 17, 1950.

CEDAR RAPIDS

"An Industrial Television System," by R. C. Webb, Faculty, Iowa State College; May 24, 1950.

CHICAGO

"The Properties and Characteristics of Color Television Systems Proposed to F.C.C.," by Frank McIntosh, Consulting Engineer; "Phonevision Progress," by J. R. Howland, Zenith Radio Corporation; April 24, 1950.

"A Circuit Theory of Neuroses," by W. S. McCulloch, University of Illinois; Election of Officers; May 19, 1950.

CINCINNATI

"Serendipity, Cybernetics, and Electronics," by W. C. White, General Electric Research Laboratory; April 18, 1950.

Spring Technical Conference; April 29, 1950.

"The Human Side of Engineering," by W. L. Webb, Bendix Aviation Corp.; May 16, 1950.

CONNECTICUT VALLEY

"Electronics in Measurement," by T. W. Wall, General Electric Co.; "The Mechanization of Sound Measurements with Electronic Aids," by W. B. Conover, General Electric Co.; "Stabilization of Testing Power," by H. F. Parker, General Electric Co.; Inspection Trip to General Electric's High Voltage Laboratory; May 18, 1950.

DAYTON

"The Engineer and His Professional Society," by D. B. Sinclair, General Radio Co.; Election of Officers; May 18, 1950

DENVER

"RCA Industrial Television System," by R. C. Webb, Iowa State College; Election of Officers; May 26, 1950.

EMPORIUM

"High-Quality Loud Speakers," by R. F. Bozak, R. F. Bozak Co.; May 31, 1950

EVANSVILLE-OWENSBORO

"Transient Response and Square Wave Testing," by J. E. Everett, Tektronic, Inc.; Tour of Electronic Tube Manufacturing Facilities at the Owensboro Plant of the General Electric Co.; May 17, 1950.

(Continued on page 38A)

Specify BREEZE "Monobloc" Waterproof and Pressure Sealed CONNECTORS

The only APPROVED Monobloc System for Advanced Radar, Communications, and Electronic Equipment

Breeze "Monoblocs", with single piece plastic inserts, offer outstanding advantages in assembly, wiring, mounting and service in the field.

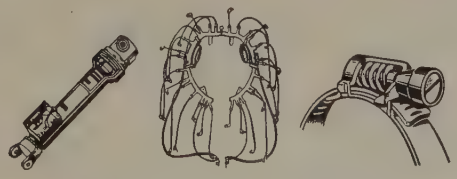
Single piece inserts make a tighter unit, eliminate the air spaces within conventional multiple-piece inserts, greatly reduce the opportunity for moisture shorts.

Removable contact pins make possible bench soldering of leads, quick, error free assembly of Breeze Waterproof Connectors and panel-type "Monobloc Miniatures."

Single-Hole Panel Mounting is all that is required for either Waterproof or Pressure Sealed types.

Pressure Sealed types are available for values up to and including 75 psi, or they can be specially engineered for greater pressures. They meet specified requirements of shock, vibration, salt spray, humidity and temperature cycling from −65° to +185° F.

Breeze "Monobloc" Waterproof and Pressure Sealed Connectors are engineered to your requirements in aluminum, brass or steel —in all sizes and capacities. They are fully tested and approved... cost no more than ordinary types.



Write for Details

If you have a tough connector problem, ask BREEZE for the answer!

Other Breeze Precision Products

ACTUATORS: All types, sizes. Complete control systems engineered to requirements. Above: Landing gear actuator Fairchild Packet.

RADIO SHIELDING: For any type of high or low tension system. New type "unit leads" or re-wirable leads. Flexible shielded conduit.

"AERO-SEAL" Worm-Drive Hose Clamps. Vibration proof, uniform clamping, use again and again. All clamps have stainless steel bands.

BREEZE

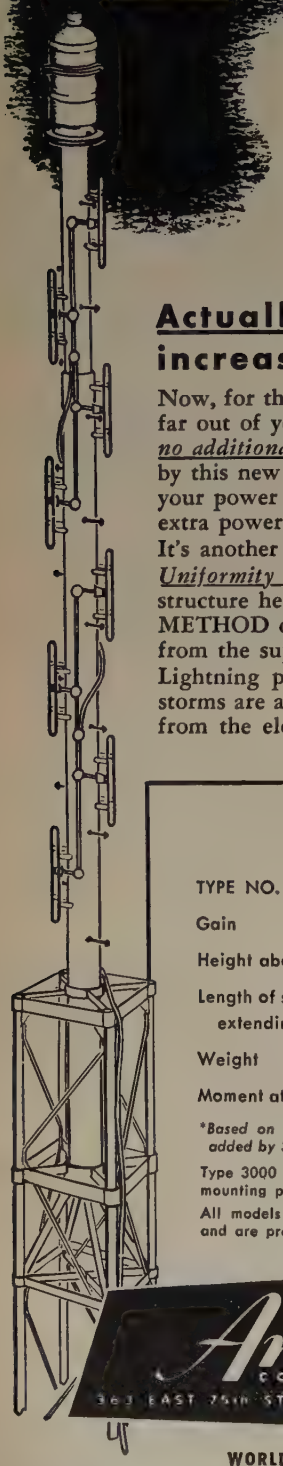
CORPORATIONS, INC.

41-G South Sixth Street, Newark 7, N.J.

NEW!

THE HIGHEST GAIN COMMUNICATIONS ANTENNA EVER BUILT!

VERTICAL RADIATION PATTERN OF TYPE 3000 ANTENNA



Actually delivers 6 db . . . . . increases your power 4 times!

Now, for the first time, you can operate in areas previously far out of your reach. This vast extra service area is yours at *no additional operating cost* because the 6 db actually delivered by this new ANDREW antenna is equivalent to increasing your power 4 TIMES! Think of the economy! This tremendous extra power also fills in any dead spots.

It's another pace-setting ANDREW "first".

Uniformity of performance is assured regardless of supporting structure height through a NEW EXCLUSIVE ANDREW METHOD of electrically isolating the radiating elements from the support structure.

Lightning protection and quieter reception during electrical storms are achieved by a DC path which conducts static charges from the elements to ground.

SPECIFICATIONS
148-174 MC

TYPE NO.	3000	3001	3002
Gain	6 db	6 db	3 db
Height above top of tower	27½ ft.	27½ ft.	13½ ft.
Length of support mast extending into tower	5 ft.	5 ft.	5 ft.
Weight	625 lbs.	375 lbs.	175 lbs.
Moment at tower top*	9300 ft. lb.	6150 ft. lb.	1600 ft. lb.

*Based on 100 mph wind loading and ½" radial ice. Moments include loading added by 300 mm beacon for Type 3000 and double obstruction light for Type 3001.

Type 3000 is designed to support a 300 mm code beacon, and includes a suitable mounting plate. Type 3001 is designed to support a double obstruction light.

All models are designed for connection to ANDREW Type 737 transmission line, and are provided with climbing steps.

All orders filled chronologically. Deliveries begin September 1. Write, wire or phone (ask for Mr. Bickel) today.

Andrew CORPORATION
363 EAST 75th STREET · CHICAGO 19

ANDREW

WORLD'S LARGEST ANTENNA EQUIPMENT SPECIALISTS

TRANSMISSION LINES FOR AM-FM-TV • ANTENNAS • DIRECTIONAL ANTENNA EQUIPMENT
ANTENNA TUNING UNITS • TOWER LIGHTING EQUIPMENT • CONSULTING ENGINEERING SERVICES

SECTION MEETINGS

(Continued from page 37A)

HAWAII

"Loran, Principles, Problems and Applications," by Paul Burhorst, 14th District Coast Guard Office; Election of Officers; May 16, 1950

INDIANAPOLIS

"Baldwin Electronic Organ," by D. W. Martin, Baldwin Piano Co.; May 19, 1950.

"Atomic Power in War and Peace," by R. J. Kryter, Esterline-Angus Co.; June 2, 1950.

LOS ANGELES

"Methods of Nuclear Radiation Measurement," by H. K. Ticho, University of California: Film: "Atomic Physics"; June 6, 1950.

NEW MEXICO

"A Multiple Sealar for Laboratory Use," by G. C. Lagomassini and E. M. Hodges, Students, University of New Mexico; "The Fixed Probes, Method of Impedance Measurement," by R. D. Ewing, Student, New Mexico College of Agriculture and Mechanic Arts; May 12, 1950

NORTH CAROLINA-VIRGINIA

"The Engineer in Electronics," by R. F. Guy, National Broadcasting Co.; May 12–13, 1950.

OMAHA-LINCOLN

"Miniature Condenser Microphone," by J. K. Hilliard, Altec-Lansing; April 20, 1950.

"The Reproduction of Music," by John Goodell Minnesota Electronics Corporation; May 23, 1950

PITTSBURGH

"Automatic Control in Telephone Switching," by William Keister, Bell Telephone Labs., Inc.; June 12, 1950.

PORTLAND

"Direct Reading Radio-Frequency Wattmeter" by W. S. Burdic, Oregon State College; "Plate Load Impedance Characteristics of an Audio-Frequency Power Amplifier," by L. B. Craine, Oregon State College; "Signal Distortion by Directional Broadcast Antennas," by C. H. Moulton, Oregon State College; April 1, 1950. "New Aircraft Landing System and Associated Equipment," by Ward Cutting, C.A.A.; April 27, 1950.

ROCHESTER

"Television Transmission," by K. J. Gardner and A. W. Balling, Radio Station WHAM-FM and TV; Election of Officers; May 25, 1950

SAN ANTONIO

"The Effect of Scattering on the Reception of Radio Signals," by A. W. Straiton, Faculty, The University of Texas; May 25, 1950.

SCHENECTADY

"Highways of Speech," by M. S. Paige, New York Telephone Co.; May 15, 1950.

Inspection of WRGB Television Station; June 19, 1950.

SEATTLE

"Modern Transmission Methods in Electrical Communications," by Ralph Bown, Bell Telephone Laboratory; May 18, 1950.

"Metal Plate Lenses for Microwaves," by J. W. Brady, Faculty, Oregon State College; Tour of the Crown-Willamette Paper Mill; May 20, 1950.

ST. LOUIS

"Pulses in Circuits and Lines," by D. L. Waidleich, Faculty, University of Missouri; May 25, 1950.

TOLEDO

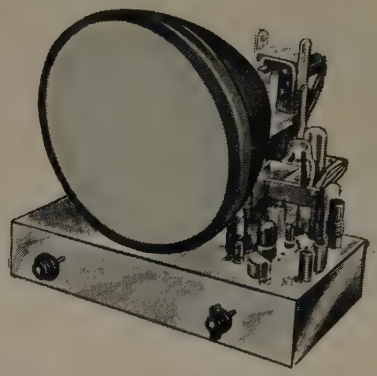
"Operations and Problems Involved in Regional Affairs," by H. E. Kranz, IRE Regional Director; Film; Election of Officers; May 15, 1950.

(Continued on page 40A)

YOU CAN HAVE THE FINEST T-V CABINET IN THE WORLD . . . BUT

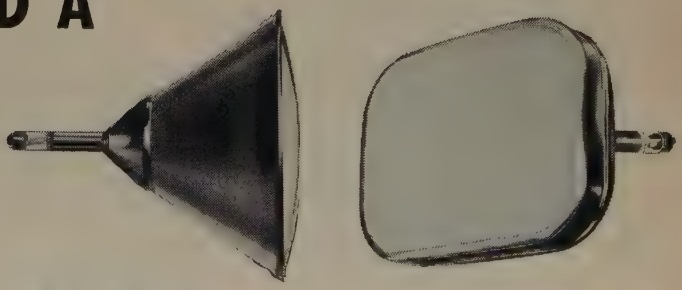
YOU AIN'T GOT NOTHIN'!

YOU CAN HAVE THE FINEST T-V CHASSIS IN THE WORLD . . .



YOU STILL AIN'T GOT NOTHIN'!

BUT WHEN YOU ADD A Sheldon PICTURE TUBE, THE FINEST IN THE WORLD . . .



YOU REALLY HAVE SUMPTHIN'!

SHELDON ELECTRIC CO.

Division of Allied Electric Products Inc.

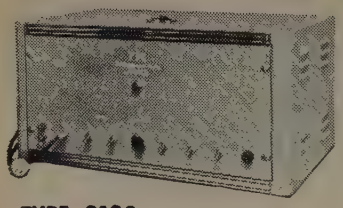
68-98 Coit Street, Irvington 11, N. J.

Branch Offices & Warehouses: **CHICAGO 7, ILL., 426 S. Clinton St.**
LOS ANGELES 26, CAL., 1755 Glendale Blvd.

SHELDON TELEVISION PICTURE TUBES • SHELDON CATHODE RAY TUBES • SPRING ACTION PLUGS
TAPMASTER EXTENSION CORD SETS & CUBE TAPS • SHELDON REFLECTOR AND INFRA-RED LAMPS
PHOTOFLOOD & PHOTOSPOT LAMPS • FLUORESCENT STARTERS & LAMPHOLDERS • RECTIFIER BULBS

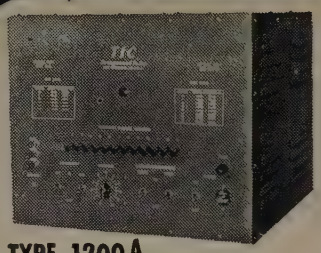
A Complete Line of PRODUCTION TEST EQUIPMENT for TV Manufacturers

Tel-Instrument has designed and provided the production test equipment for many of the major TV manufacturers. A complete line of instruments designed to be unusually critical in the testing of TV receivers is available. They are the result of the wide practical experience of Tel-Instrument engineers plus a complete understanding of the production problems of TV manufacturing.



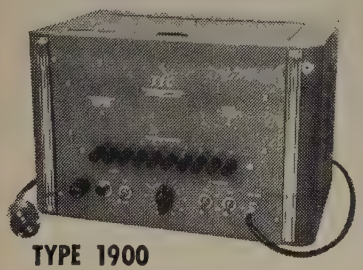
TYPE 2120
R.F. PICTURE SIGNAL GENERATOR

Provides picture and sound carrier. Modulated by standard R.M.A. composite picture signal. Sound carrier stability suitable for testing Inter Carrier type receivers. Internal 400 cycle FM and External audio with 75 microsecond pre-emphasis. Output max. 0.1v p-p across 75 ohm line. Available channels 2-13.



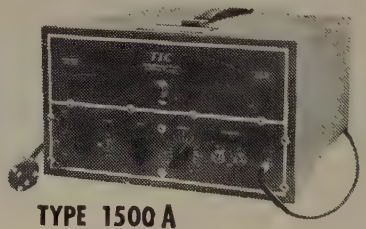
TYPE 1200 A
12 CHANNEL
R.F. SWEEP GENERATOR

Intended for precise adjustment of R.F. head oscillator coils and R.F. band pass circuits. Pulse type markers at picture and sound carrier frequencies extend to zero signal reference base line. Accuracy of markers 0.02% of carrier frequency. 12 to 15 MC. sweep on all channels. Max. 1.V peak output across a 75 ohm line. Provisions for balanced input receivers. Instant selection by push button.



TYPE 1900
CRYSTAL CONTROLLED
MULTI-FREQUENCY GENERATOR

A 10 frequency, 400 cps. modulated crystal controlled oscillator, ideal for production line adjustment of stagger tuned I.F. amplifiers. Available with crystals ranging from 4.5 to 40 M.C. Output frequency accurate to 0.02%. Immediate push button selection of frequency. Output attenuator range .5V to 500 microvolts. Self contained regulated power supply.



TYPE 1500 A
I.F. WOBBULATOR

A two band sweeping generator covering the range of 4.5 to 50 M.C. Capable of a band width of approximately ±25% on either band. Five pulse type crystal generated markers to specified frequencies available for each band. Accuracy of markers .05%. Zero signal reference base line, with markers extending to base line. I.V output max. into 75 ohms. A saw sweep available for "X" axis of scope.

Write for Detailed Engineering Data Sheets.

Tel-Instrument Co. Inc.
54 PATERSON AVENUE • EAST RUTHERFORD, N. J.

(Continued from page 38A)

WASHINGTON

"Analysis of Performance of the Omni-Bearing-Distance Navigation System," by J. W. Leas, Air Navigation Development Board; May 8, 1950.

WILLIAMSPORT

"Microwave Transmission Characteristics," by E. H. Boden, Faculty, Bucknell University; May 16, 1950.

Election of Officers; May 16, 1950.

SUBSECTIONS

LONG ISLAND

Field Trip; Brookhaven National Laboratories; May 20, 1950.

NORTHERN NEW JERSEY

"The Columbia Long-Playing Microgroove Recording System," by Rene Snepvanger, Columbia Broadcasting System; Election of Officers; May 24, 1950.

MONMOUTH COUNTY

"Experimental Radiotelephone Service for Train Passengers," by Newton Monk, Bell Telephone Laboratories; May 17, 1950.

ALABAMA POLYTECHNIC INSTITUTE, IRE BRANCH

Film; Election of Officers; May 22, 1950.

CALIFORNIA INSTITUTE OF TECHNOLOGY, IRE BRANCH

"Problems in the Design and Production of Television Receivers," by John A. Rankin, Hoffman Radio Company; May 22, 1950.

UNIVERSITY OF COLORADO, IRE-AIEE BRANCH

Films; "Theory of Flight," "Problems of Flight"; Election of Officers; May 3, 1950.

"The Network Analyzer," by W. Morgan, Reclamation Bureau at Denver; May 17, 1950.

UNIVERSITY OF DENVER, IRE-AIEE BRANCH

Business Meeting; May 25, 1950.

FENN COLLEGE, IRE BRANCH

Election of Officers; May 15, 1950.

JOHN CARROLL UNIVERSITY, IRE BRANCH

"The Spectrograph," by Clifford Poutney, Graduate Student and Faculty, John Carroll University; Business Meeting; May 11, 1950.

"The Basic Questions in Television," by Joseph Epperson, Scripps Howard Television Stations; May 25, 1950.

UNIVERSITY OF KENTUCKY, IRE BRANCH

Tour of the Long Lines Department of the American Telephone and Telegraph Co., by A. F. Gleaves, American Telephone and Telegraph Co.; May 12, 1950.

"Silicone Insulation in the Electrical Industry," by Mr. Noegle, Dow Corning Corporation; May 16, 1950.

"Electronics in the Electrical Power Industry," by E. W. Brown, Jr., Kentucky Utilities Company; May 23, 1950.

UNIVERSITY OF MAINE, IRE BRANCH

"Institute Affairs," by R. E. Frank; "Process Control," by Richard Schlotterbeck; Business Meeting; May 24, 1950.

(Continued on page 42A)

WILCOX...

First Choice of SOUTHERN AIRWAYS

Southern Airways Selects Wilcox Type 428
FACTORY PACKAGED VHF STATION
For All Ground Stations

A WILCOX FACTORY PACKAGED STATION OFFERS YOU:

1. OPERATING CONVENIENCE

All controls are within easy reach of the operator. Conveniently grouped telephone handset, typewriter, filing cabinet, and writing desk assure efficient operation.

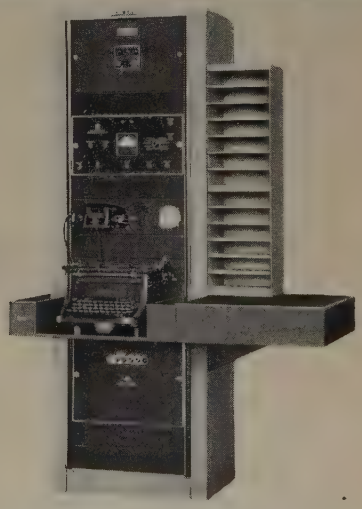
2. INSTALLATION ECONOMY

All wiring inside the 72-inch-high standard relay rack is completed at the factory. No costly on-the-job wiring needs to be done. Just install the antenna, plug the station into any standard electrical outlet, and it is ready for operation.

3. MAINTENANCE EFFICIENCY

Simple, conventional circuits minimize the number and types of tubes, require no special training, techniques, or test equipment. All adjustments can be made from the front of the panels. All components are easily removable by means of plug and receptacle connections. This means low-cost maintenance.

Write Today for complete information on the Wilcox Type 428 Packaged VHF Ground Station



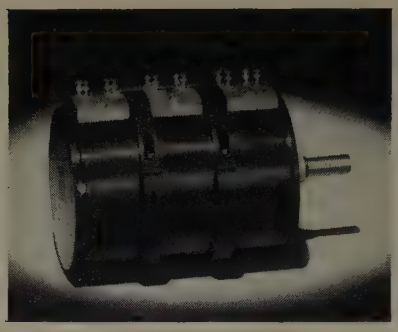
Type 428 Packaged VHF Station includes:
—406A fixed frequency 50 watt transmitter
—305A fixed frequency receiver
—407A power supply
—614A VHF antenna

WILCOX
ELECTRIC COMPANY
KANSAS CITY 1, MISSOURI, U. S. A.

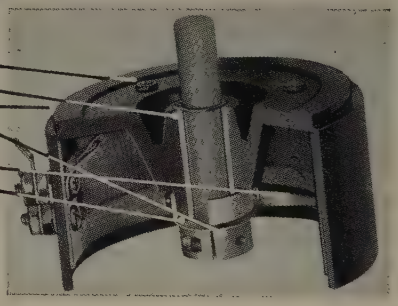
There's a TIC Potentiometer for every application

TIC for top electrical and mechanical precision

Type RV2 High Precision Potentiometer
One of a series of semi-standardized types of metal-base potentiometers with exceptionally high electrical accuracy and mechanical precision. For both linear and *non-linear* functions. Designed for precision instrument, computer and military applications. Accurate phasing of individual units possible with exclusive clamp-ring method of ganging.



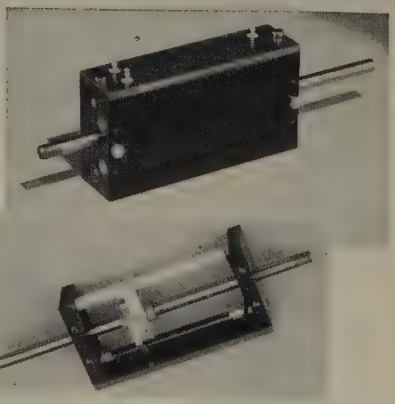
TIC for precision and economy

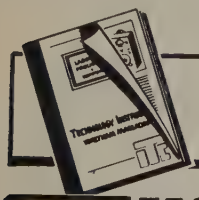

Tapped mounting inserts
Bronze bushing
Totally enclosed with cover
"Constrict-O-Grip" clamping to shaft —(no set screws)
Precious metal contacts
Silver overlay on rotor take-off slip ring

Type RV3 Precision Potentiometers
. . . available in models for either *linear* or *non-linear* functions with stock resistance values ranging from 100Ω to 200,000Ω and power ratings of 8 and 12 watts. 360° mechanical rotation or limited by stops as desired. Models with 5% total resistance accuracy — $6.00 . . . 1% accuracy — $8.00. Special models available for high humidity applications.

TIC for special use . . .

Type RVT Translatory Potentiometer
Actuated by longitudinal instead of rotating motion providing linear electrical output proportional to shaft displacement. Used as a position indicator, high amplitude displacement type pickup and for studying low frequency motion or vibration. Features exceptionally high linearity and resolution. Available in various lengths depending on amplitude being studied.





Valuable catalog — yours for the asking. Contains detailed information on all TIC Instruments, Potentiometers and other equipment. Get your copy without obligation — write today.

TECHNOLOGY INSTRUMENT CORP.
1058 Main Street, Waltham 54, Massachusetts

Engineering Representatives Cleveland, Ohio — PRospect 6171
Chicago, Ill.-UPtown 8-1141 Boonton, N.J.-Boonton 8-3097 Rochester, N.Y.-Genesee 3547M
Cambridge, Mass.-ELiot 4-1751 Canaan, Conn.-Canaan 649 Hollywood, Cal.-HOllywood 9-6305
Manhasset, N.Y.-Manhasset 7-3424

(Continued from page 40A)

MARQUETTE UNIVERSITY, IRE-AIEE BRANCH
Field Trip through the West Allis Works of the Allis-Chalmers Manufacturing Company; May 24, 1950.

UNIVERSITY OF MIAMI, IRE BRANCH
Business Meeting; April 26, 1950.

MICHIGAN STATE COLLEGE, IRE-AIEE BRANCH
"Fundamentals of Co-ordination of Power and Communication Systems," by W. Smith, Michigan Bell Telephone; May 3, 1950.
"Motor Control," by Mr. Beck, Graybar Electric; May 10, 1950.
Annual Picnic; May 17, 1950.
Films: "The Banshee," and "What Price Motors"; May 24, 1950.

UNIVERSITY OF MINNESOTA, IRE-AIEE BRANCH
Business Meeting; October 27, 1949.
Business Meeting; November 22, 1949.
"Electronic Wizards," by C. N. Hoyler, RCA Laboratories; Business Meeting; February 27, 1950.
Student Talks; April 24, 1950.
Election of officers; April 28, 1950.

NEW MEXICO COLLEGE OF AGRICULTURE AND MECHANIC ARTS, IRE-AIEE BRANCH
"The General Electric Training Program," by Max Lane, formerly with General Electric Company; "Opportunities for an Electrical Engineer with Phillips Petroleum Company," by F. E. Cockrell, El Paso Electric Company; Election of Officers; April 27, 1950.
Business Meeting; May 11, 1950.

OHIO STATE UNIVERSITY, IRE-AIEE BRANCH
Election of Officers; May 11, 1950.

OREGON STATE COLLEGE, IRE BRANCH
"Television," by R. J. Newman, Product Sales Engineer, R.C.A.; April 27, 1950.
"Some Problems of Material Procurement," by Carl Bjorquist, Chief, Materials Section, B.P.A.; Election of Officers; May 10, 1950.

RENSSELAER POLYTECHNIC INSTITUTE, IRE-AIEE BRANCH
Election of Officers; May 10, 1950.

SAN DIEGO STATE COLLEGE, IRE BRANCH
"The Closed Loop Television System for San Diego State College," by Richard Silberman, Student, San Diego State College; May 16, 1950.

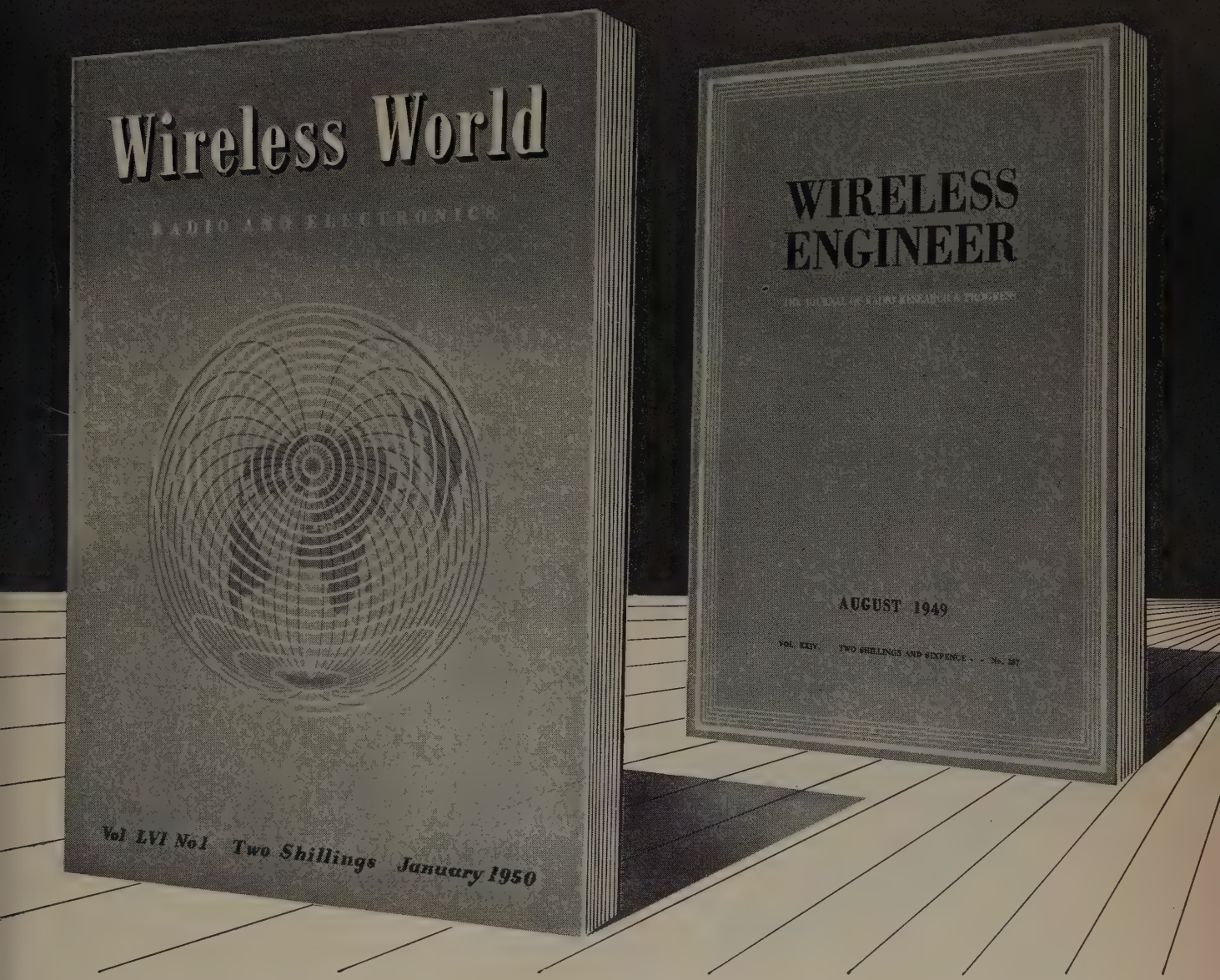
SAN JOSE STATE COLLEGE, IRE BRANCH
"Ionosphere," by R. A. Helliwell, Faculty, Stanford University; May 24, 1950.

SOUTHERN METHODIST UNIVERSITY IRE-AIEE BRANCH
Film: "Jet Propulsion"; Election of Officers; June 16, 1950.

ST. LOUIS UNIVERSITY, IRE BRANCH
"One to Sixty Million," by Myron Waggoner, Southwestern Bell Telephone Co.; May 4, 1950.
Election of Officers; May 11, 1950.
Picnic; June 4, 1950.

TULANE UNIVERSITY, IRE-AIEE BRANCH
Business Meeting; May 1, 1950.

UNIVERSITY OF WYOMING, IRE-AIEE BRANCH
"Microwaves," by Mr. Strieby, American Telephone and Telegraph Co.; May 18, 1950.
Films: "Thunderbolt Hunters," and "This Is Resistance Welding"; Business Meeting; May 19, 1950.



For accurate and up-to-date news of every British development in Radio, Television and Electronics

WIRELESS WORLD. Britain's leading technical magazine in the general field of radio, television and electronics. Founded nearly 40 years ago, it provides a complete and accurate survey of the newest British technique in design and manufacture. Critical reviews of the latest equipment, broadcast receivers and components of all types are regularly included. Theoretical articles deal with design data and circuits for every application. Each issue is profusely illustrated and news from all parts of the world is fully reported. Monthly, 2s. Annual Subscription - - £1 6s. ($4.50).

WIRELESS ENGINEER. The journal of radio research and progress. Produced for research engineers, designers and students in radio, television and electronics, it is accepted internationally as a source of information for advanced workers and wireless engineers. Editorial policy is to publish only original work, selected by an Editorial Advisory Board representative of the foremost technical bodies in British radio engineering and electronics. Monthly, 2s. 6d. Annual Subscription, £1 12s. ($5.50).

ASSOCIATED ILIFFE PUBLICATIONS

ASSOCIATED TECHNICAL BOOKS. "Wireless Direction Finding" (4th Edition) by R. Keen, B. Eng. (Hons.), A.M.I.E.E. An up-to-date and comprehensive work on the subject. 45s. ($7.50). "Radio Laboratory Handbook" by M. G. Scroggie, B.Sc., M.I.E.E. 430 pages (4th Edition). 13s. ($2.00)

Subscriptions can be placed with British Publications Inc.: 150 East 37th Street, New York, 16, N.Y., or sent direct by International Money Order to Dorset House, Stamford Street, London, S.E.1, England. Cables: "Iliffepress, Sedist, London"

Gentlemen: IT'S A KNOCKOUT!

it's the new CP MODEL 55 SWITCH FOR RF AND POWER SERVICE

NO BIGGER'N A WRISTWATCH
BUT PACKED WITH PERFORMANCE!

The new model 55 shorting type switch reflects, in miniature, many design features of large CP switches. With a maximum of 18 contact positions in the single pole style, it's also available in two or three pole styles. Of course several sections may be "ganged". Silver path from terminal to terminal is provided. Flash-over voltage at 60 cycles is 1000 volts peak. Current rating is 2 amperes. Model 55 is only one of seven standard stock model switches of our manufacture. A catalog describing them all will be sent upon request.

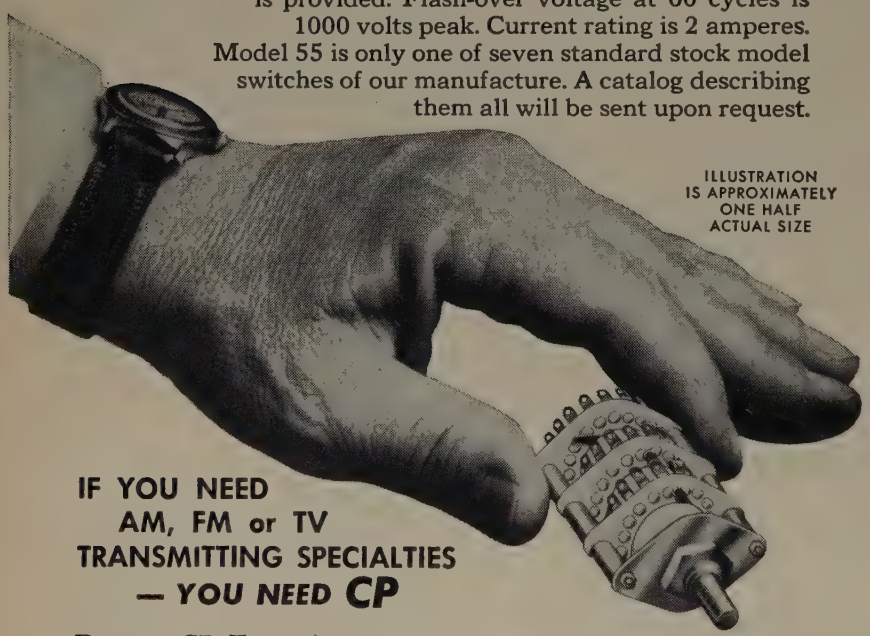


ILLUSTRATION IS APPROXIMATELY ONE HALF ACTUAL SIZE

IF YOU NEED AM, FM or TV TRANSMITTING SPECIALTIES — *YOU NEED* CP

Because CP Transmission Equipment has proven outstanding in service and performance in hundreds of major installations throughout the nation. If you have a specific problem pertaining to any of the products listed, our engineers will be happy to help you solve it. Consultation can be arranged to suit your convenience—without obligation.

- SEAL-O-FLANGE TRANSMISSION LINE
- TOWER HARDWARE
- AUTO-DRYAIRE DEHYDRATORS
- LO-LOSS SWITCHES
- COAXIAL DIPOLE ANTENNAS

Communication Products Company, Inc.

KEYPORT NEW JERSEY

MEMBERSHIP

The following transfers and admissions were approved and will be effective as of August 1, 1950:

Transfer to Senior Member

Curtis, T. P., 104 Bruce St., Scotia 2, N. Y.
Fiet, O. O., 113 W. Park Ave., Oaklyn, N. J.
Fong, A., 1328 Parkinson Ave., Palo Alto, Calif.
Good, W. E., Westinghouse Research Laboratory, East Pittsburgh, Pa.
Helliwell, R. A., Electronics Bldg., Stanford, Calif.
Jamieson, H. W., 2121 Overland Ave., Los Angeles, Calif.
Kearney, J. W., 160 Old Country Rd., Mineola, L. I., N. Y.
Kingan, J. J., 4008 Wilson Ave., Montreal, Que., Canada
Klayton, M. H., 12 Wardell Pl., Wanamassa, N. J.
Knauss, H. C., 35 Harding Rd., Lexington 73, Mass.
Lonsdale, E. M., 226 McLean St., Iowa City, Iowa
Minor, M. J., Rt. 3, Charlotte 3, N. C.
Ogle, H. M., 1951 Clement Rd., Schenectady 10, N. Y.
Palter, N. H., 40-16–247 St., Little Neck, L. I., N. Y.
Pappenfus, E. W., 1101–30 Dr., S. E., Cedar Rapids, Iowa
Reed, R. I., 617 McClellan St, Schenectady, N. Y.
Reitz, N. J., Sylvania Electric Products Inc., Emporium, Pa.
Scott, M. C., Jr., Station WIOD, Miami 30, Fla.
Singleton, H. E., Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge 39, Mass.
Steidley, J. W., U. S. Navy Electronics Laboratory, San Diego, Calif.
Stephenson, J. G., Airborne Instruments Laboratory, 160 Old Country Rd., Mineola, L. I., N. Y.
Talpey, R. G., Special Development Group, RCA Victor, Lancaster, Pa.
Vogeley, C. E., Jr., 211 West St., Pittsburgh 21, Pa.
Weissman, S., 321 W. Norman Ave., Dayton 5, Ohio

Admission to Senior Member

Bradley, J. K., 326 Hamilton Ave., Hasbrouck Heights, N. J.
Branch, G. E., 49 Woodmont Rd., Belle Haven, Alexandria, Va.
George, R. H., 703 N. Chauncey Ave., W. Lafayette, Ind.
Goudet, G., 24 Rue Morere, Paris 14, France
Johnson, R. E., American Telephone and Telegraph Co., 195 Broadway, New York, N. Y.
Manty, W. A., Nestor Engineering Co., 764 Palisade Ave., Teaneck, N. J.
Matthews, R. P., Federal Electric Manufacturing Co., Ltd., 9600 St. Lawrence Blvd., Montreal 14, Que., Canada
Miller, L., 140 Atlantic Ave., Long Branch, N. J.
Ortusi, J. A., 23 Rue du Maroc, Paris 19, France
Pintell, R. H., 1749 Grand Concourse, New York 53, N. Y.
Schmidt, F. W., 10 Garret St., Cedar Grove, N. J.
Sloan, D. H., Rm. 120 T-11, University of California, Berkeley, Calif.
Vollum, H., 1115 S. E. Lambert St., Portland 2, Ore.
Woodson, R. A., 6923 N. Kolmar Ave., Lincolnwood, Chicago, Ill.

Transfer to Member

Cahn, S. L., 341 E. Ohio St., Chicago 11, Ill.
Ellis, A. R., 1244 Sevier Ave., Menlo Park, Calif.
Faltin, J. W., 482 N. Windsor Ave., Brightwaters, N. Y.
Farnsworth, N. B., Box 134, Ellet Sta., Akron 12, Ohio
Hamm, N. G., 5449 Charles St., Philadelphia 24, Pa.
Lephakis, A. J., Box 69, Cambridge 39, Mass.

(Continued on page 46A)

Announcing the H-14 SIGNAL GENERATOR 108-118 megacycles

Newest in ARC's Line of Signal Generators

Checks on...

- 24 Omni courses
- Left-center-right on Phase-localizer
- Left-center-right on Amplitude-localizer
- Omni course sensitivity
- To-From and Flag-alarm operation
- All necessary quantitative bench tests

Use the H-14 for Testing Omni Receiving Units in Aircraft . . . . . or on the Bench.

The Type H-14 Signal Generator, 108-118 megacycles provides a standard signal source for the complete testing of VHF airborne omnirange and localizer receivers in aircraft or on the bench. It provides for testing 24 omni courses, plus left-center-right checks on both amplitude and phase localizers. Aircraft may be checked out quickly and accurately just before take-off. RF output for ramp checks, 1 volt into 52 ohm line and for bench checks, 0-10,000 microvolts. Provision for external voice or other modulation. AF output available for bench maintenance and trouble shooting.

PRICE: $885.00 net, f.o.b. Boonton, N. J.

MICROWAVE TEST SET . . . TYPE H-10

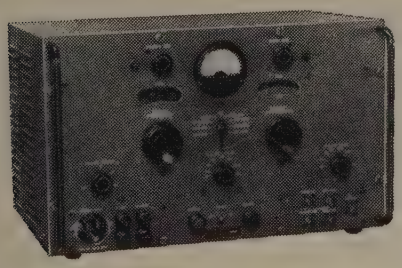
23,500-24,500 MEGACYCLES

Provides source of cw or pulse frequency-modulated RF, power level —37 to —90 dbm. RF power meter measures levels from +7 to +30 dbm. Frequency meter for measuring output or input RF accurate to better than 20 mc. Primary purpose of the H-10 is to measure receiver sensitivity, bandwidth, frequency, recovery time, and overload characteristics, plus transmitter power and frequency. Recommended as a standard source of RF for research or production testing. Equal to military TS-223/AP.

PRICE: $1692.00 net, f.o.b. Boonton, N. J.

UHF SIGNAL GENERATOR . . . TYPE H-12

900-2100 MEGACYCLES



Provides source of cw or pulse amplitude-modulated RF, power level 0 to —120 dbm. Internal pulse circuits with controls for width, delay, and rate, and provision for external pulsing. Single dial tuning, frequency calibration accurate to better than 1%. Built to Navy specifications for research and production testing. Equal to military TS-419/U.

PRICE: $1950.00 net, f.o.b. Boonton, N. J.

ARC COMMUNICATION AND NAVIGATION EQUIPMENT

Aircraft Radio Corporation also manufactures LF and VHF airborne communication and navigation equipments — all CAA-Type-Certificated for scheduled aircarrier use or for those whose type of flying requires a high degree of reliability and performance. Equipment consists of light, small units which can be combined to provide the required operation, whether it be the 1 Receiver/1 Transmitter (15-pound) installation in a 2-place helicopter, or a 3 Receiver/2 Transmitter/VHF Omni installation (70 pounds) in larger 2-engine aircraft.

Aircraft Radio Corporation

Boonton, N. J.

Dependable Electronic Equipment Since 1928

WRITE TODAY for descriptive bulletins on any of these instruments

MORE GEO. STEVENS COIL WINDING EQUIPMENT IS IN USE THAN ALL OTHER MAKES COMBINED!

• **MORE OUTPUT . . . LOWER COSTS** . . . from *EXCLUSIVE* SPEED FEATURE. Universal motors permit variable speeds without changing belts and pulleys. Coil design permitting, speeds as high as 7500 RPM are not uncommon.

• **PORTABILITY.** Conveniently carried from place to place. Machines come mounted on bases to constitute one complete unit.

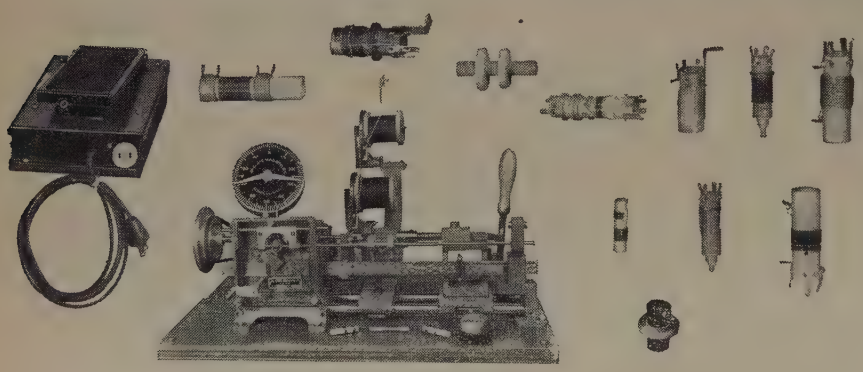
• **MUCH LOWER ORIGINAL COST.** The same investment buys more GEO. STEVENS machines than any other coil winding machines.

• **LONG LIFE.** Most of the original GEO. STEVENS machines bought 14 years ago are still operating daily at full capacity.

• **MUCH FASTER CHANGING OF SET-UPS** than any other general purpose coil winding machine. Quickly changed gears and cams save time between jobs.

• **VERY LOW MAINTENANCE.** Replacement parts are inexpensive, can be replaced in minutes, and are stocked for "same day" shipment, thus saving valuable production time.

• **EASIEST TO OPERATE.** In one hour, any girl can learn to operate a GEO. STEVENS machine.



Progressive universal winding machine, Model 125, handles space wound coils and solenoids up to 8" in length, progressive universal coils up to 4" in length and 3" in diameter, universal coils up to ¾" in width, and I.F. coils. Winds wire from 20 to 44 gauge. Cams are stocked from ¾" to 1/16" in decrements of 1/64". Sizes larger than ¾" or less than 1/64" are made upon request.

Cam, gears and idler forming the pattern are enclosed in front. Traverse rack is driven by change gears and idler enclosed in back of the head. The traverse rack has an adjustable stop to insure return to identical starting position. Large ball bearings on head stock spindle give long life and easy running. Ball bearing tailstock with spring tension lever permits quick change of coil forms.

Standard equipment: ¼ H.P. universal motor, foot operated speed controller, V belt drive, and double spool carrier with two adjustable oilite bearing tensions to control wire during winding.

Dial Counter (Model 50 or 51) with 6" full vision clock dial, accurately registers all turns.

There is a GEO. STEVENS machine for every coil winding need. Machines that wind ANY kind of coil are available for laboratory or production line. . . . Send in a sample of your coil or a print to determine which model best fits your needs. Special designs can be made for special applications. Write for further information today.

World's Largest Manufacturer of Coil Winding Machines

REPRESENTATIVES

Frank Tatro
6022 No. Rogers Ave., Chicago 30, Illinois
Ralph K. Reid
1911 W. 9th St., Los Angeles 6, California
R. F. Staff & Co.
1213 W. 3rd St., Cleveland 13, Ohio

GEO. STEVENS
MFG. CO., INC.
Pulaski Road at Peterson
Chicago 30, Illinois

MEMBERSHIP

(Continued from page 44A)

Love, E. J., 9264 Boleyn, Detroit 24, Mich.
Luhrs, C. H., 115 Great Oak Lane, Pleasantville, N. Y.
McGowan, M. L., 3521 N. 58 St., Omaha 4, Neb.
McMasters, P. A., c/o Electronics Officer, Box 1042, Key West Naval Sta., Key West, Fla.
Moore, R. K., 215 Fall Creek Dr., Ithaca, N. Y.
Ohlinger, P. M., Portsmouth, Iowa
Parr, J. O., Jr., Box 2061, San Antonio 6, Tex.
Purnell, L. S., 25 Tanager Lane, Levittown, L. I., N. Y.
Raleigh, J. H., Box 232, Point Loma Sta., San Diego 6, Calif.
Roberts, E. A., 6024 W. Eddy St., Chicago 34, Ill.
Russell, G. M., American Telephone and Telegraph Co., 195 Broadway, New York 7, N. Y.
Sandberg, H. L., 838 Camburn Ct., S. E., Cedar Rapids, Iowa
Schachat, T., 5067 Parkglen Ave., Los Angeles 43, Calif.
Shaw, G. J., 701 Belmont St., Belmont 79, Mass.
Tepper, H. H., 135–04 Elder Ave., Flushing, L. I., N. Y.
Thompson, R. D., 39 Chestnut St., Wallington R.F.D. 1, East Rutherford, N. J.
Toomin, H., 362 Forrest, Beaumont, Tex.
Van Weele, J. C., Connetquot Dr., Oakdale, N. Y.
Wiese, A. H., 1123 Bellevue Ave., St. Louis 17, Mo.

Admission to Member

Abouchanab, M. T., Engineer-in-Charge, Hashimite Broadcasting House, Ramallah via Amman, Trans-Jordan
Anderson, A. E., Pinewood Lane, Mansfield Center, Conn.
Ashby, G. L., 109 Sunrise Lane, Levittown, L. I., N. Y.
Clark, A. H., c/o Directorate of Communications, Hq. Continental Air Command, Mitchel Air Force Base, Hempstead, L. I., N. Y.
Clark, R. G., 10629 Wilton Pl., Los Angeles 47, Calif.
Field, R. W., 808 Frederica St., Owensboro, Ky.
Glancy, D. R., 584 Cosie Dr., St. Louis 15, Mo.
Hata, F. T., S-42, Ft. Belvoir, Va.
Keonjan, E., 225 E. 69 St., New York 21, N. Y.
Lyon, W. T., 224 South St., Hingham, Mass.
Margolick, F. H., 4662 Mariette Ave., Montreal, Que., Canada
Metten, W. H., 25 Walnut Park, Roxbury 19, Mass.
Michaelis, H. P., Box 322, Watertown, Mass.
O'Connor, G. J., Gilfillan Brothers, Inc., 1815 Venice Blvd., Los Angeles 6, Calif.
Owen, E. R., 1611 Central St., House 7, Evanston, Ill.
Purinton, H. G., 600 Walker Ave., Apt. F, Baltimore 12, Md.
Rao, S. S., Shettye Bldg., 49, Fourth Fl., Elphinstone Rd., Parel, Bombay 12, India
Rogers, T. F., 44 Kendall Park, Waltham, Mass.
Rotolo, N. V., 176 Hind Dr., Honolulu 16, T. H.
Shoulders, K. R., Route 2, Box 539B, Irving, Tex.
Wohl, R. J., 1149 E. 17 St., Brooklyn 30, N. Y.

The following elections to Associate grade were approved, and are effective as of July 1, 1950:

Aiello, W. P., 1305 Iris St., Los Alamos, N. Mex.
Beal, E., 45 W. 97 St., New York 25, N. Y.
Becker, F. M., 5208 S. Natoma, Chicago, Ill.
Bernard, N., 1104 Carroll Pl. New York, N. Y.
Bonwit, S. E., 2800–31, S. E., Washington, D. C.
Brazdionis, J., 20-11 Bleecker St., Brooklyn 27, N. Y.
Brendle, T. A., 12 Old Perry Hgwy., R.D. 1, Wexford, Pa.
Burns, R. E., 4035 N. Sheridan Rd., Chicago, Ill.
Chang, S. Y., Electrical Engineering Department, University of Massachusetts, Amherst, Mass.

(Continued on page 47A)

(Continued from page 46A)

Clark, C. E., 728 Fifth St., Marietta, Ohio
Cobbs, E. R., R.F.D. 2, Beloit, Ohio
Cockrell, J. H., Route 2, Box 6-A, Plant City, Fla.
Delong, W. A., 501 S. Fourth St., Effingham, Ill.
Dickensheets, L., 930 Wayne St., Topeka, Kan.
Dolce, S. L., 20 Shute Path, Newton, Mass.
Eakins, J. R., 38 Lankin Blvd., Toronto, Ont., Canada
Eggers, P., 57 Pleasant St., West Newton 65, Mass.
Eicher, W. F., 4415-1-2 Woodman Ave., Sherman Oaks, Calif.
Eldridge, D. F., 1520 Alki Ave., Seattle 6, Wash.
Evenson, R. C., 4041 Berryman Ave., Culver City, Calif.
Feehrer, M. R., 1510 Scott St., Williamsport 22, Pa.
Ferro, J. A., 2500–72 Ct., Elmwood Park 35, Ill.
Ford, W. W., 2 Woodside Rd., Madison, N. J.
Frye, F. X., 556 Windsor Rd., New Milford, N. J.
Galluppi, A. J., 233 W. Menomonee St., Chicago 14, Ill.
Gardiner, K. W. 340 W. Latham, Phoenix, Ariz.
Genco, F., 6407½–11 Ave., Los Angeles 37, Calif.
Greiger, G., 21-68–29 St., Astoria, L. I., N. Y.
Haas, R. S., Rhode Island State College, Kingston, R. I.
Haimowitz, S., 1185 Grand Concourse, New York 52, N. Y.
Harmer, H. S., Pacific Telephone and Telegraph Co., 509 S. W. Oak St., Portland 4, Ore.
Harris, H. F., 6102 Eastridge Dr., Indianapolis, Ind.
Harting, D. R., Route 3, Box R-32, Auburn, Wash.
Hawkins, R. L., 4117 Illinois Ave., N. W., Washington 11, D. C.
Hollen, F. M., U.S.S. Markab Adzi, Orange, Tex.
Holmes, W. R., 701 E. Broad St., Angola, Ind.
Huston, P. D., 2616 Dayton St., Chicago 14, Ill.
Hyland, R. C., 286 Essex St., Weymouth 88, Mass.
Jacobs, V. J., 19 E. St. Joseph, Apt. 2, Indianapolis, Ind.
Kalin, T., 39 Hartwell St., Fitchburg, Mass.
Kelly, I. E., 4153 Kenmore Ave., Chicago 13, Ill.
Klane, C. H., 148 Maple St., Malden 48, Mass.
Klinko, E. H., 27 Linden St., Binghamton, N. Y.
Lacey, H. F., 612 Van Buren St., N. W., Washington 12, D. C.
Lannary, J., 28 Riverside St., Watertown 72, Mass.
Lawson, R. G., Port Arthur College, Box 511, Port Arthur, Tex.
Leffler, J. M., General Delivery, China Lake, Calif.
LoGatto, S. J., 2nd Radio Squadron, Mobile, A.P.O. 175, c/o PM, New York, N. Y.
Martin, J. O., O.I.C. Clear Creek Radio, Range Sta., R.R. 2, Port Rowan, Ont., Canada
McDonald, J. J., 9236 S. Aberdeen St., Chicago, Ill.
McGuyer, C. C., 1321 S. Governor St., Evansville 13, Ind.
McPherson, J. R., 1519 Olympia Way, S. W., Atlanta, Ga.
Meisling, T. H., 4256 Gilbert St., Oakland 11, Calif.
Moran, T. G., 1173 Nelson Ave., New York, N. Y.
Morris, W. J., 6215 Linwood Ave., Cleveland 3, Ohio
Oliver, J. J., 30 Brainerd Rd., Allston, Mass.
Oujevolk, G. B., 92 Liberty St., New York 6, N. Y.
Peto, C. J., Jr., 6239 S. Kilpatrick, Chicago 29, Ill.
Pidhayny, D. D., 3613 W. Washington Blvd., Los Angeles, Calif.
Rao, C. V., Madira, Hyderabad State, India
Reitlinger, N. E., 101–80 Rd., Kew Gardens, L. I., N. Y.
Rizzo, S. J., 1215 Niagara St., Buffalo 13, N. Y.
Robinson, R. D., YMCA, 13 State St., Schenectady, N. Y.
Rose, A. B., Jr., 331A Harvard St., Cambridge, Mass.
Sable, R. L., 217 W. Fifth St., Emporium, Pa.
Show, O. C., 311 N. E. 103 Ave., Portland 16, Ore.

(Continued on page 48A)

PRESTO... *most carefully made recording discs in the world*

step 2-lacquer coating the disc

Through 15 years of experience in manufacturing fine recording discs, Presto has learned that the choice of lacquer, how it is stored, tested and maintained, how it is applied to the aluminum base are among the most important considerations.

Specifications for recording lacquer have been carefully worked out after many laboratory and turntable tests. Compounded from a well-guarded formula, Presto lacquer is stored in constantly agitated tanks to insure even flowing.

In the Presto coating room, polished aluminum blanks are fed into the processing "tunnel" where liquid lacquer is automatically flowed on their surfaces to just the right thickness. After completing their 1½ hour trip through this 550 foot tunnel, the coated discs are carefully placed in racks for "curing."

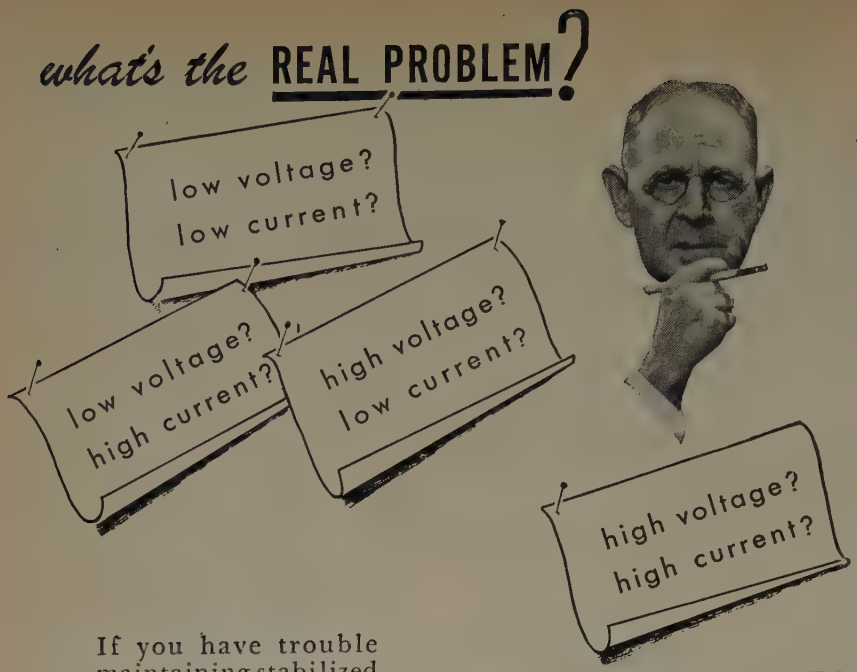
Whenever you see the Presto label on a disc, it is your assurance of the most carefully manufactured, best performing and most permanent disc anywhere.

The famous PRESTO "Green Label" . . . world's finest recording disc.

PRESTO
RECORDING CORPORATION
Paramus, New Jersey
Mailing Address:
Box 500, Hackensack, New Jersey

In Canada:
Walter P. Downs, Ltd.
Dominion Sq. Bldg.
Montreal, Canada

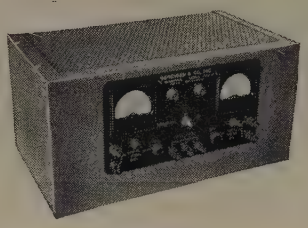
Overseas:
The M. Simons & Son Co., Inc.
25 Warren Street
New York, N. Y.



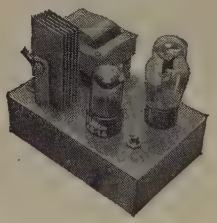
If you have trouble maintaining stabilized DC Voltage under changing Load conditions, it's time to investigate the Sorensen line of Nobatrons.

- **Common Nobatron Specifications:** Regulation Accuracy 0.2% from 0.1 load to full load; Ripple Voltage 1%; Recovery time 0.2 seconds under most severe load or input conditions; 95-130 VAC single phase 50-60 cycles: Adapter available for 230 VAC operation.
- **Ratings**
  Nobatron — 6, 12, 28, 48, 125 volts from 5—350 amperes
  B-Nobatron — 325, 500, 1000 volts — 125 ma.; 300 ma. & 500 ma.
  DC Standards — 2, 6, 15, 25, 50, 75, 150, 300 volts — 15, 30 and 50 ma.
- **Problems?** Sorensen Engineers are always at your service to help solve unusual applications.
- **Sorensen manufactures:**
  AC line regulators 60 and 400 cycles; Regulated DC Power Sources, Electronic Inverters; Voltage Reference Standards; Custom Built Transformers; Saturable Core Reactors.

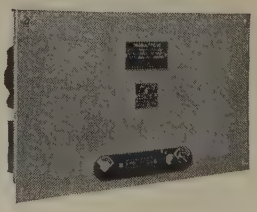
TYPICAL DC SOURCES



MODEL 325B
0-325 volts; 125 ma.



MODEL VS-50-50
50 volts @ 50 ma.



MODEL E-6-15
6 volts; 1.5-15 amperes

MODEL 500 B
0-500 volts; 300 ma.

WRITE TODAY For Catalog B1049 For The Complete Line And Prices.

controlled converted POWER *Sorensen* and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

(Continued from page 47A)

Tait, J. S. R., Radio Section W.E.E., R.C.A.F., Edmonton, Alta., Canada
Tanner, W. E., Gotthelfstrasse 16, Aarau, Switzerland
Tutwiler, C. E., Jr., c/o C.A.A., 84 Marietta St., Atlanta, Ga.
Uribe, E., 1254 Guerrero St., San Francisco, Calif.
Uyeda, M. M., 4135 S. Berkeley, Chicago 15, Ill.
Voss, R. G. P., University of Pretoria, Pretoria, Transvaal, South Africa
Whiting, R. F., 1416 Jackson Blvd., Chicago 7, Ill.
Wolak, S., Box 272, Seneca Falls, N. Y.
Wood, L. E., 4342 Burns Ave., Los Angeles 27, Calif.

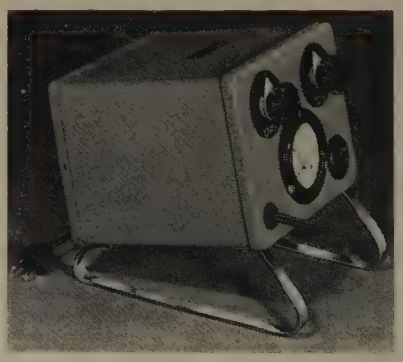
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 30A)

Adjusting Isolation Transformer

A new voltage adjusting isolation transformer, a service tool, has been announced by the **Halldorson Co.**, 4500 Ravenswood Ave., Chicago, Ill.



The new unit, Model N-202, was first introduced at the Parts Show in Chicago. According to the manufacturer, Model N-202 gives the operator close control over the line voltage on his bench, yet isolates it from his work.

Included in the many features is the provision for varying the voltage in approximately 1½-volt steps by means of two switch knobs on the panel. If the line voltage at the input is the standard rated 117 volts, it can be varied through a wide range of from about 95- to 145-volts. If the voltage drops to around 90, it can be varied from 75- to 115-volts. The rated capacity at 117- volt input is 500 watts. A volt meter with accuracy to 2½ per cent registers the output voltage.

(Continued on page 49A)

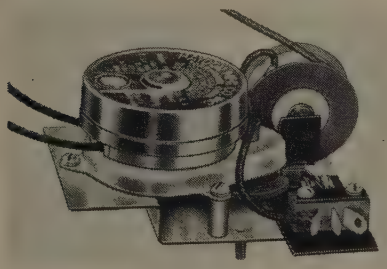
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Audible Signal Timer

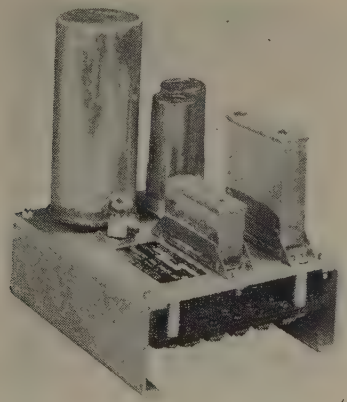
The Haydon Manufacturing Co., Inc., Torrington, Conn., has introduced a new, low-cost timing device with an audible signal for large volume applications. The timer, known as the Series 8010, is available in a wide range of timing intervals made possible because of the many motor speeds available. At the end of the preset interval the signal, a buzzer, sounds continuously until manually turned off, demanding whatever action is required.



The 8010 is a compact unit, measuring $4\frac{1}{32}$ inches by $2\frac{11}{32}$ inches by $1\frac{25}{32}$ inches. It can be mounted and operated in any position; rotates clockwise or counter-clockwise and may be set in either direction to start, or when in operation. The unit features a snap action for quick break; is rated for 16 amperes 250 volts, $\frac{1}{2}$ horsepower 250 volts ac. The basic motor operating the device features a 450-rpm rotor speed for quiet operation and long life. The motor is totally enclosed, with a dual system of controlled lubrication.

Electronic Tuning Fork

American Time Products, Inc., 500 Fifth Ave., New York 19, N. Y. announces a new frequency standard tuning fork, Type 2001-2.

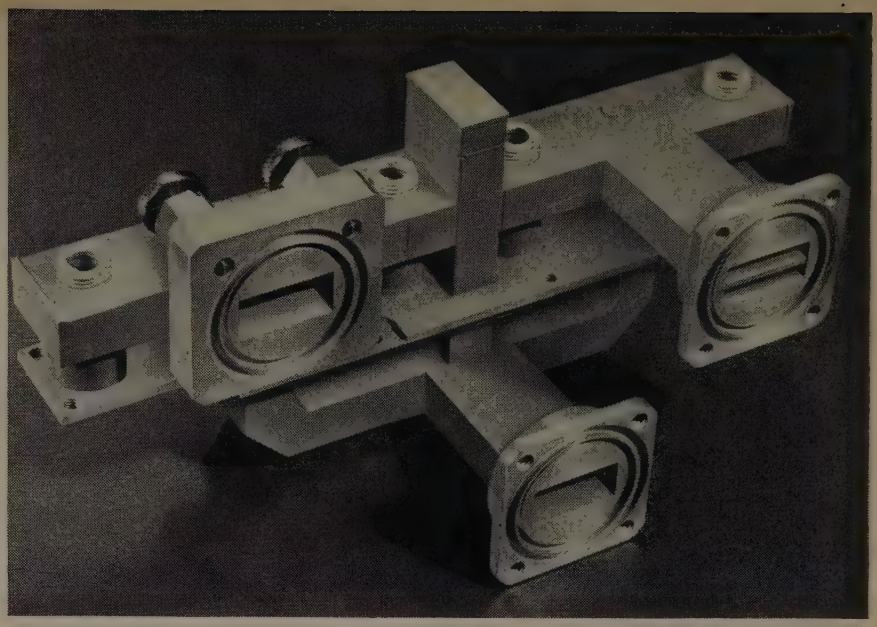


The manufacturer claims it will deliver an accurate, stable source of any frequency between 200 and 1,500 cps. Dividers and multipliers available for other frequencies.

The Type 2001-2 is of compact, miniature construction that permits ready integration into basic equipment.

It is suitable for navigational aids, controlling gyros, firing electronic inverters,

(Continued on page 56A)



Need help with microwave transmission lines?...call TERPENING

The microwave mixer shown above was designed and produced on special order, in quantity, in our plant. Though made up from a number of different sections brazed together, special jigs, fixtures, and skilled techniques made it possible to hold tolerances between the outer flange center lines to ± .001".

Whether it's a special component, such as the mixer shown, or complete microwave transmission systems, we're set up to produce them with a high degree of precision from blueprints or performance specs. Although our engineering staff, laboratories, and fully equipped shop are usually busy on government contracts, our unusual facilities may permit us to work with you on special components for military or other microwave systems. We shall be happy to talk with you about your present and/or future needs.

L. H. TERPENING COMPANY

DESIGN • RESEARCH • PRODUCTION

Microwave Transmission Lines and Associated Components

16 West 61st St. • New York 23, N. Y. • Circle 6-4760

SCIENTISTS AND ENGINEERS

for

challenging research and advanced development in fields of

RADAR
GYROSCOPES
SERVOMECHANISMS
MECHANICAL SYSTEMS
ELECTRONICS CIRCUITS
APPLIED PHYSICS AND MATH
PRECISION MECHANICAL DEVICES
ELECTRICAL SYSTEM DESIGN
GENERAL ELECTRONICS
INSTRUMENTATION
MICROWAVES
COMPUTORS
AUTOPILOTS

Scientific or engineering degree and extensive technical experience required.

WRITE:

Manager, ENGINEERING PERSONNEL

BELL AIRCRAFT CORPORATION

P.O. Box 1, Buffalo 5, N.Y.

POSITIONS OPEN FOR MEN HOLDING Ph.D OR M.S. DEGREE

Openings for men holding the Ph.D. or M.S. Degree in the fields of photo-surfaces, secondary emission, solid state, both light and electron optics, mechanics, electronic circuits, analog computers and servo-mechanisms.

Salary commensurate with experience and ability—Excellent opportunity for suitably qualified personnel.

Please furnish complete résumé of education, experience and salary required to:

CAPEHART-FARNSWORTH CORPORATION, INDUSTRIAL RELATIONS & PERSONNEL DEPARTMENT, FORT WAYNE 1, INDIANA

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

ASSISTANT TO CHIEF ENGINEER

Large speciality transformer manufacturer wants man experienced in small transformer work. Excellent opportunity for qualified man. Please state education and experience, also salary on last or present position. Southern Ohio location. All replies held strictly confidential. Suitable arrangements will be made to interview qualified applicants. Box 606.

PROFESSOR

Ph.D. or D.Sc. required. Age 40-45 with good teaching experience. Some industrial experience helpful. Large midwestern school; undergraduate and graduate program. State salary expected and qualifications. Box 609.

ELECTRONICS ENGINEER

Electronics engineer about 33 years old who preferably has had some graduate training and who is experienced in electronic circuit and apparatus design and development work. Wanted by a small but expanding and well known company specializing in precision electronic instruments. Located in New Jersey about 30 miles from New York City. Salary up to $7,000 plus bonus. Our employees know of this ad. Box 611.

ENGINEERS

Engineers and assistants needed at new Motorola laboratory in Phoenix, Arizona. Engineers are required to be graduates of accredited engineering school, specialists in VHF and UHF receiver design, microwave communication pulse circuits, VHF, UHF and microwave antenna design, etc. Assistants must be engineering graduates with electronic experience. Replies should be sent to Daniel E. Noble, 4545 Augusta Blvd., Chicago 51, Ill., stating education, experience and past salary schedules.

TELEVISION ENGINEERS

Television engineers with at least 3 years design experience, preferably lectrical engineering, as production engineer for nationally known radio and TV manufacturer located in upper New York state. Box 612.

ANTENNA ENGINEER

Long Island laboratory has an opening that is unusually suitable for an engineer who prefers a small company, is interested in specializing in VHF and microwave antennas and who has carried real responsibility in this or closely related field. Box 614.

ACOUSTIC ENGINEER

For research and design on loudspeakers and microphones. Must have a thorough background in acoustics, audio

(Continued on page 51A)

PHYSICISTS AND ENGINEERS

You can find plenty of positions where you will work on minor improvements on radar, telemetering systems, and other conventional devices. However, you will find very few positions where you can break ground in new fields having tremendous significance. This you can do at the JACOBS INSTRUMENT COMPANY, whose entire effort is devoted to pioneering activities in new fields that it has opened up itself. One of these fields, for example, is that of ultra-high speed, ultra-compact digital computers and controllers. This company's JAINCOMP family of computers dominates this field. Other equally important fields are being developed. Engineers and physicists with sound backgrounds and experience in the design of advanced electronic circuits or precision mechanical instruments may qualify, also individuals with good backgrounds in applied physics. A few openings exist for outstanding junior E. E.'s and physicists, also experienced technicians; applicants for these positions must apply in person.

JACOBS
INSTRUMENT CO.
4718 Bethesda Ave.
Bethesda 14, Maryland

ENGINEERS

RESEARCH AND DEVELOPMENT

Career Positions
for
Top Engineers and Analysts

SENIOR ELECTRONICS AND ELECTRONICS ENGINEERS—**B.S. or M.S. degree; 2 to 7 years experience in radar, television, pulse, video or display circuit design.**

DIGITAL COMPUTER DESIGN ENGINEERS

AUTOMATIC TELEPHONE SWITCHBOARD DESIGN ENGINEER

SENIOR ELECTRO-MECHANICAL ENGINEERS—**Degree and at least 4 years experience in servomechanism analogue computers, special weapons or system design.**

Submit detailed resume. Personal interview will be arranged.

THE GLENN L. MARTIN COMPANY
Employment Department
Baltimore 3, Maryland

(Continued from page 50A)

and measuring techniques, with a minimum of 5 years laboratory or practical design experience on loudspeakers or transducers. Progressive manufacturer in New York suburban area. Send complete resume and state salary requirements. Box 415.

RADIO ENGINEER

Electrical or radio engineer, must have development experience in audio frequency circuit design. Acoustical experience also helpful. State experience, age, salary desired. Box 616.

ELECTRONIC ENGINEER

At least 5 years post-college experience in development DC amplifier, digital computers, pulse and servo design. Established company. Classified work. New York City. Box 617.

PROFESSOR

Professor of communications engineering needed for fall 1950 by southeastern university. Will be in charge of graduate work and research activities. $6,500.00 for nine months with extra income for summer teaching, or sponsored research. Must have Ph.D. or D.Sc. degree. Write Box 618.

JUNIOR ELECTRICAL ENGINEER

Attractive opportunity for Junior Electrical Engineer with manufacturer of UHF equipment. Preferably a man with one or two years experience. Reply to Box 619.

PROJECT RADIO ENGINEER

To take responsible charge of design of radio communications systems between Hawaiian Islands. Experience in VHF and microwave links design desirable. College training or equivalent necessary. Live in Honolulu. Contact Mutual Telephone Co. Box 2200, Honolulu, T.H.

INSTRUCTOR

Southern private vocational school desires and additional full time instructor in radio or television. Teaching experience preferred. Salary about $250.00 per month depending on qualifications. Please send complete resume in first letter to: Mr. J. D. Muse, Box 505, Atlanta, Georgia.

ENGINEER

Chief systems test engineer with practical experience in electro-mechanical and hydraulic systems to direct systems testing on guided missiles. Familiarity with production testing techniques and test equipment in above fields is desirable. Excellent opportunity for someone who can organize a rapidly expanding facility. Direct inquiries to Manager, Engineering Personnel, Bell Aircraft Corp., P.O. Box 1, Buffalo, N.Y.

SPECIFICATION WRITERS

Specification writers capable of clear, concise technical description of the design, construction and testing of missle and electronic equipment. Knowledge of military specifications and familiarity

(Continued on page 52A)

RCA VICTOR
Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 850, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

PHYSICISTS AND SENIOR RESEARCH ENGINEERS

POSITIONS NOW OPEN

Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

- Microwave Techniques
- Moving Target Indication
- Servomechanisms
- Applied Physics
- Gyroscopic Equipment
- Optical Equipment
- Computers
- Pulse Techniques
- Radar
- Fire Control
- Circuit Analysis
- Autopilot Design
- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

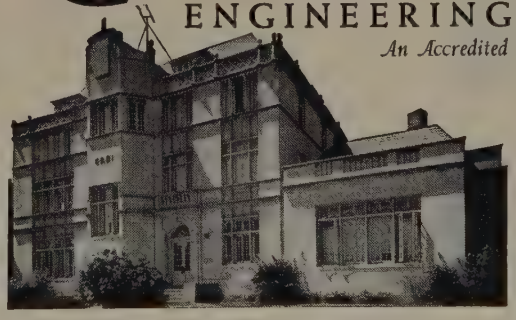
are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

NORTH AMERICAN AVIATION, INC.
Aerophysics Laboratory
Box No. N-4, 12214 South Lakewood Blvd.
Downey, California

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO
ENGINEERING INSTITUTE

An Accredited Technical Institute



ADVANCED HOME STUDY AND RESIDENCE COURSES IN PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING

Request your free home study or resident school catalog by writing to:

DEPT. 268B
16th and PARK ROAD, N.W.,
WASHINGTON 10, D.C.

Approved for Veteran Training

Engineers—Physicists

- ***What do you want in a position?***
- ***What are your aims and ambitions?***

SENIORS

Realizing that each of us has personal job requirements, the W. L. Maxson Corporation offers special opportunities if you are heavily experienced in research and development on radar, computers and associated equipment.

Please address your job requirements and résumé to A. Hoffsommer for individual attention.

THE W. L. MAXSON CORPORATION
460 W. 34th Street **New York 1, N.Y.**

Acme Electric has been identified with the electronic industry since the crystal set days. The vast store of experience that Acme engineers have accumulated over these many years can be of considerable value in helping you solve your electronic transformer problems. We offer transformer engineering cooperation and facilities to build quality transformers in quantity production.

ACME ELECTRIC CORP.

448 Water Street Cuba, N. Y., U. S. A.

Acme ACME Electric
TRANSFORMERS

POSITIONS OPEN

(Continued from page 51A)

with aircraft and electronic components is essential. Direct inquiries to Manager, Engineering Personnel, Bell Aircraft Corp., P.O. Box 1, Buffalo 5, N.Y.

ENGINEER

Engineer, electrolytic capacitor, at least 5 years experience in design and development. Write resume of experience and salary expected. Box 620.

RADIO ENGINEER

Radio engineer wanted by prominent Chicago electronic manufacturer to design and supervise manufacture of full line of commercial amplifiers. Must have engineering degree or equivalent and minimum of 2 years design experience in commercial P.A. systems. Give details including age, education, experience, reference, availability and salary expected. Box 621.

ENGINEER

Excellent opportunity for engineer to apply microwave measurements and techniques to development and manufacture of magnetrons and klystrons. Pulse circuit knowledge also valuable. B.S. degree and experience or advanced degree with heavy concentration on above required. State salary expected and qualifications. Location New York City. Box 622.

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

ENGINEER

M.S. in E.E. communications option, June 1949 B.E.E. Cum Laude June 1948. Tau Beta Pi, Eta Kappa Nu. Age 24, single. Navy electronic technician program 2 years and some radio and television experience. Desires electronic design, development or research position New York-Long Island area. Box 387 W.

ELECTRONIC ENGINEER

M.S.E.E., B.S.E.E., communications, Oklahoma A. and M. College. 2 years oil

(Continued on page 53A)

PROJECT ENGINEERS

Real opportunities exist for Graduate Engineers with design and development experience in any of the following: Servomechanisms, radar, microwave techniques, microwave antenna design, communications equipment, electron optics, pulse transformers, fractional h.p. motors.

SEND COMPLETE RESUME TO EMPLOYMENT OFFICE.

SPERRY
GYROSCOPE CO.
DIVISION OF
THE SPERRY CORP.
GREAT NECK, LONG ISLAND

HIGHEST QUALITY ELECTRONIC COMPONENTS

Large Quantities in Stock for Immediate Delivery

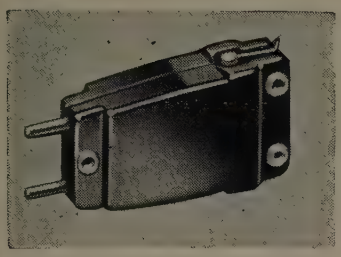
RELAYS **TUBES**
TRANSFORMERS **CHOKES**
VOLUME CONTROLS **RECTIFIERS**
WIRE & CABLE **TUBE SOCKETS**
RESISTORS (WIRE WOUND, CARBON, etc.)
CONDENSERS (MOLDED, CERAMIC, OIL FILLED, etc.)
SWITCHES (TOGGLE, MINIATURE, WAFER, etc.)

All standard brands, inspected and guaranteed by Wells Sales.

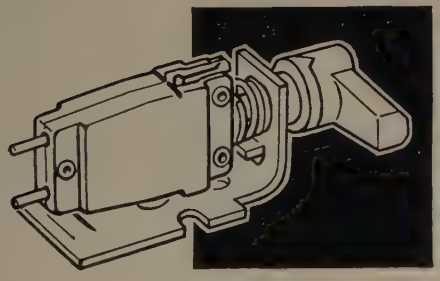
Manufacturers: Write for complete Electronic Catalog and prices. Dept. P

WELLS SALES, INC.
320 N. LA SALLE ST.
CHICAGO 10, ILL.

Webster Electric Model "A" Cartridge



with Twist Mechanism



A complete unit with top performance and absolute minimum of service and installation problems.

The twist mechanism is factory assembled with Model A7 cartridge in place, ready for installation in tone arms without adjustment or modification. This completely assembled unit gives positive tracking at all playing speeds. High vertical and lateral compliance eliminate "skating". The simple, foolproof twist mechanism gives positive indexing, eliminating the possibility of twisting and damaging the leads in the tone arm.

There are no delicate parts to break or get out of order. The Model A7 with twist mechanism reverses through a 180 degree arc for playing either 33⅓ — 45 or 78 R.P.M. records.

Send for a sample assembly today... try it . . . then note first hand the advanced improvement.

WEBSTER ELECTRIC

Webster Electric Company, Racine, Wis. • Established 1909

"Where Quality is a Responsibility and Fair Dealing an Obligation"

Positions Wanted

(Continued from page 52A)

company research lab. 2 years military Airborne radio maintenance. Thesis work parasitic antenna array impedance. 1st radio telephone, Amateur Class A, DXCC. Married, age 24. Desires design, development, research anywhere. Box 429 W.

RADIO ELECTRONICS TECHNICIAN

American, age 27, single. Desires long term position anywhere in Philippines. Amiable disposition. Speaks some Tagalog and Visayan. 10 years military, amateur and commercial radio experience. Box 431 W.

ELECTRONICS ENGINEER

B.E.E. September 1949, Georgia Institute of Technology, communications option. Age 27, single. Former Navy ETM. Limited production experience. Desires position with a future in electronics or communications. Salary secondary. Location immaterial. Box 432 W.

PHYSICIST

B.S. physics, University of Washington 1949, age 26. 6 years sub-professional radio and radar experience. FCC licensed radio telephone, 1st class. Primary interest: electronic instrumentation anywhere in U.S. Box 433 W.

ENGINEER

B.S.E. June 1949, University of Nebraska. Communications option. Single, age 26. Eta Kappa Nu, Pi Mu Epsilon. Desires position offering prospects of research or of work toward advanced degree. Salary and location secondary. Box 434 W.

ENGINEER

B.E.E. January 1950. Communications option. Rensselaer Polytechnic Institute. First quarter of class. 2 years Army experience as Chief Carrier Repeaterman. Age 31, single. Neat appearance. Salary and location secondary. Interested in communications, electronics and UHF. Box 435 W.

COMMUNICATIONS ENGINEER

7 years training in electronics. B.S.E.E. Graduate Navy electronics school and National Radio Institute. 1st class phone FCC license. Age 23, single. Technician experience. Interested in TV or other communications engineering. Box 436 W.

ENGINEER-EXECUTIVE

B.S. Iowa State, M.S. Purdue. M.B.A. Stanford, Graduate School of Business. E.E. Stanford, Graduate School of Engineering. 3 years Naval engineering officer; Bowdoin M.I.T. radar schools, radar material sea duty. Experience in research, engineering, production, business and industrial economics. Tau Beta Pi, Eta Kappa Nu, Sigma Xi. Interested in operation of a small business manufacturing and technical electronic product, or in a responsible position with a larger company in electronics industry. Box 437 W.

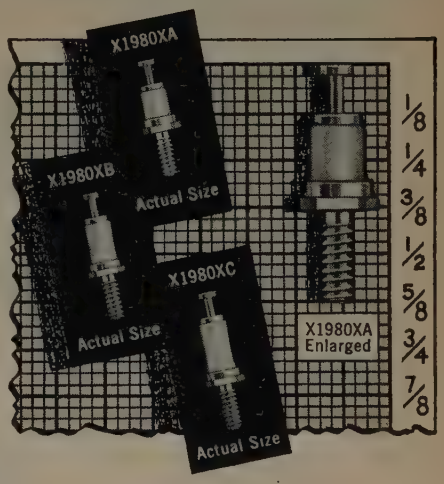
ELECTRONIC ENGINEER

B.S.E.E. and three-quarters toward M.S. Specialist in electronics, radio and control. 1½ years as B-29 wing hq. staff

(Continued on page 54A)

New Miniature Insulated Terminals

to help your miniaturization program



Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eighths of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .141" OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.

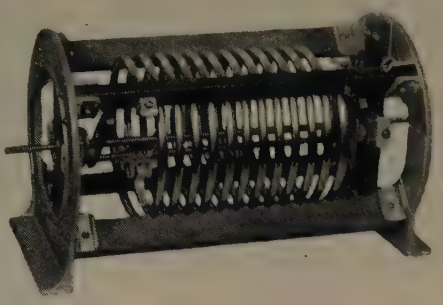
custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
456 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

THERE'S A JOHNSON INDUCTOR TO FIT EVERY NEED

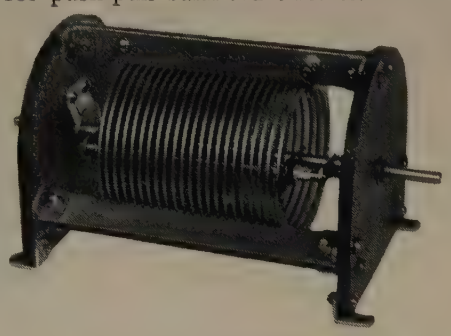
IN YEARS of serving the manufacturers of transmitting and RF heating equipment, JOHNSON has evolved an extremely diverse line of inductors. From a comparatively few basic designs and with standardized parts it is possible to "tailor" an inductor for virtually any RF power application. This technique results in reasonable manufacturing costs and surprisingly good delivery on special as well as standard inductors. Examples of JOHNSON inductors are shown below.

224 Series



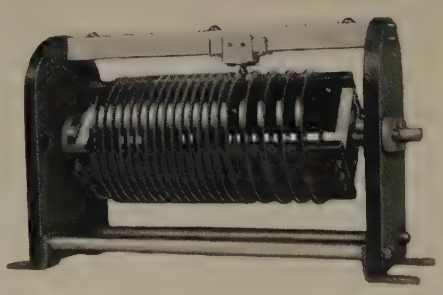
Standard 224 inductors capable of carrying current up to 50 amperes are available with ½" copper tubing windings to 50 microhenries. With ⅜" tubing, current may be 30 amperes, inductance to 110 microhenries. Insulation is glass bound mica, end frames cast aluminum, roller contact is silver plated beryllium copper. A special 224 inductor is also available with dual windings and two contacts for push-pull balanced circuits.

222 Series



JOHNSON 222 inductors are edgewound with ½" x .090 plated copper strip, are rated at currents up to 20 amperes depending upon frequency. Insulation is glass bound mica. Inductance is determined by the specific application.

226 Series



This 226 variable inductor features a rotating coil with optional variable pitch for extended frequency coverage. The winding's conductor is ¼" x .125" silver plated edgewise wound copper strip. Use of silver contacts assures low contact resistance. Depending upon winding pitch, frequency and allowable temperature rise, maximum current is 12 amperes. Inductor is wound to the specific requirements of the application: insulation glass bound mica.

OTHER INDUCTORS

In addition to these sample types, the JOHNSON line includes many other variable and fixed inductors for low, medium and high power applications. Fixed inductors are available with single or multiple windings, fixed or variable coupling windings and with electrostatic shields if desired.

There is a JOHNSON inductor to fit your needs. In large quantities or small, we will be glad to quote on your requirements.

JOHNSON . . . *a famous name in Radio!*

E. F. JOHNSON CO., WASECA, MINNESOTA

Positions Wanted

(Continued from page 53A)

radar and radio officer; 2 years as E.E. instructor at prominent university. Age 30, married, 1 child. Conscientious, alert, congenial, excellent references. Primary interest: electronic or control development. Box 438 W.

ENGINEER-PHYSICIST

B.E.E. January 1949; M.A. in physics, May 1950, Columbia University; Experience in teaching, design and construction of highly specialized electronic instrumentation involving research and technical paper publication. HAM experience 10 years on UHF to SHF. Member Tau Beta Pi, Eta Kappa Nu. State P.E. in training. Age 27, single. Prefer New York City vicinity but not exclusively. Box 440 W.

ELECTRONIC ENGINEER

Electronic engineer. Age 41. 7 years college; 15 years responsible practical experience in electronic operation, design and research. Now employed as consultant on job which will be completed this fall. Desires responsible position, credentials forwarded upon request. Salary open. Address: American, 72 Mococa, Sao Paulo, Brazil.

SALES, FIELD, OR APPLICATION ENGINEER

B.S.E.E. June 1950, Newark College of Engineering. Age 24. Single. Interested in position which combines engineering and "people." Navy 3 years, Electronic Technician 1/c. Some teaching, writing and industrial experience. Member Omicron Delta Kappa. Resume on request. Box 441 W.

ENGINEER

Engineering Aide, Graduate RCA Institute, 2 years advanced technology course, 2½ years experience as a laboratory electronic mechanic. Age 29, married. College background. Prefer work in eastern U.S. Box 439 W.

ELECTRICAL ENGINEER

Electrical engineer. Graduate of Iowa State College, June 1950, communication option. 6 months acetylene and electric welding experience. 14 months machinist apprentice training. Class A Amateur Radio Operator's license. Age 24, married. Location immaterial. Box 452 W.

ENGINEER

Position desired testing, design, research on electronic instruments (particularly interested in pulse and timing networks) or teaching electronic fundamentals, transients, and a.c. theory. Education: B.S.E.E., B.S. mathematics, graduate work in mathematics and physics. Experience: 2 years teaching mathematics and electrical engineering. Box 453 W.

ENGINEER

B.E.E. Pratt Institute, June 1950, top fifth of class. Desires start in electronic control and/or servomechanism. 2 years experience in testing. Salary secondary. Box 454 W.

ELECTRONIC ENGINEER

Electronic engineer, B.S.E.E., M.S.E.E. Age 28. Tau Beta Pi, Eta Kappa Nu. Experience: 1 year part time teaching; 2

(Continued on page 55A)

Positions Wanted

(Continued from page 54A)

years Navy Airborne electronics officer; 4 years development of digital computers, magnetic recording systems, and electromechanical devices. Box 455 W.

ENGINEER

B.E.E. Cornell, June 1950. Tau Beta Pi, Eta Kappa Nu. Some experience as laboratory assistant and in radio manufacture. Seeking position in communications or electronics development, design or research. Age 25. New York City or eastern U.S. location preferred. Starting salary secondary. Resume on request. Box 456 W.

ELECTRONICS ENGINEER

B.E.E. City College of New York, June 1950. Age 25, married. 1 year assistant in development of new oscilloscope. 1 year as electronic equipment specialist with Navy catalog office. 1 year as radio serviceman. AETM 1/c in Navy. Desires work in electronics or communications. Will relocate if necessary. Box 457 W.

ELECTRICAL ENGINEER

Electrical Engineer, age 43, single. B.S.E.E. 1¼ years design and development of transformers and coils for electronic equipment through manufacture. 2½ years electrical design; 1½ years Chief Electrical Engineer; 2 years

(Continued on page 56A)

The *Berkeley*
MODEL 410
INDUSTRIAL
COUNTER

★ **HIGH SPEED COUNTING**—Any mechanical, electrical or optical events that can be converted to changing electrical voltages can be counted at rates up to 10,000 per second.

★ **DIRECT READING**—no interpolation necessary; capacity of 1,000,000,000 counts.

★ **VERSATILE**—easily adapted for precise revolution counting, linear measurements, frequency measurement, RF interpolation, nuclear counting, as well as virtually all laboratory and industrial high speed counting applications.

★

Complete description **and specifications are yours for the asking.**

Please request Bulletin PI-410.

Berkeley Scientific Company

SIXTH & NEVIN AVENUE • RICHMOND, CALIFORNIA

Positions available for

SENIOR ELECTRONIC ENGINEERS

with

Development & Design Experience

in

MICROWAVE RECEIVERS
PULSED CIRCUITS
SONAR EQUIPMENTS
MICROWAVE COMMUNICATIONS SYSTEMS

Opportunity For Advancement Limited only by Individual Ability

Send complete Resume to:
Personnel Department

MELPAR, INC.
452 Swann Ave.
Alexandria, Virginia

SMALL
PARTS
Cost less when made by
MULTI-SWAGE

The economy way to get a million small parts similar to these —

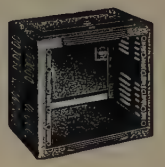
Examine the tubular and solid metal parts shown here twice size. If you use anything similar . . . in quantities of over a million . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

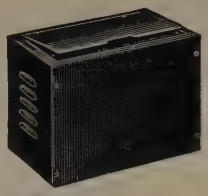
THE BEAD CHAIN MANUFACTURING CO.,
Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

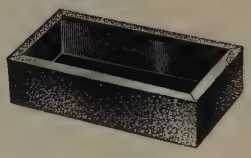
Let's talk Price

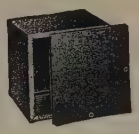
If your own sheet metal fabricating department is overloaded or if you are looking for a new source of supply, it will pay you to investigate the production facilities of Bud Radio.

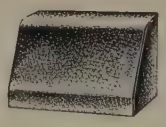
Every month we produce thousands of sheet metal products for our own use and for industries throughout the country. Our specialized facilities enable us to turn out quality products at prices that will surprise you.











YOUR SPECIAL may be our STOCK ITEM

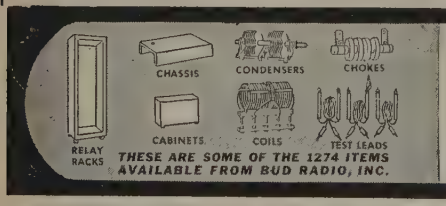
Regardless of your need for sheet metal products, we probably have a stock item that will fulfill your requirements. Often a slight change in one of our standard models will eliminate the necessity of special tools and dies and thereby cut your cost.

We make over 400 different sheet metal products as standard items, any one of which may be just what you need.

Our own large demand for steel and aluminum enable you to take advantage of large scale purchasing power. The engineering department is available for consultation on cost saving methods.

Let's talk about price. Whether your requirements are small or large, you will save time and money by consulting us first. Send us your blue prints for estimates or our representative will call at your convenience.

Write for Special Sheet Metal Catalog



BUD RADIO, INC.

BUD

2110 E. 55th ST. • CLEVELAND 3, OHIO

***For Stability . . .* CONTINENTAL "NOBLELOY" RESISTORS**

- Engineered Performance
- Metal Film
- Range ½ ohm to 30 megohm
- Ratings, ½, 1, 2 and 5 Watt
- Tolerance ½%, 1% and 5%

The "Nobleloy" type X resistors assure dependable operating characteristics for many critical applications at economical savings.

Write for further details

CONTINENTAL CARBON, INC. CLEVELAND 11, OHIO

Positions Wanted

(Continued from page 55A)

engineer-draftsman; 1 year construction and inspection—power and light engineering and telephone conduit installation. Desires responsible position with electronic transformer manufacturer or research. Wish to locate southwest. Box 463 W.

ELECTRONIC ENGINEER

B.S.E.E. Oklahoma Institute of Technology 1950. Communications major. 9 hours towards Master's degree. 3 years Naval Airborne radio and radar maintenance. 5½ years 1st class machinist with Sperry. Age 31, single. Desires position with future in research, development, medical electronics, communications or electronic work. Anywhere in U.S. Box 464 W.

ELECTRONIC ENGINEER

B.S.E.E. communications, Oklahoma A. and M. College, June 1950. Eta Kappa Nu. 18 hours advanced graduate work. Age 24, single. Infantry 2 years. Informal varied experience in field of electronics. Desires position in research, design or development in any phase of electronics, preferably microwaves. Location immaterial. Box 465 W.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

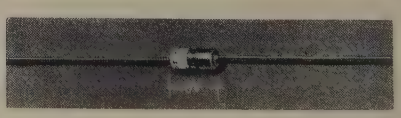
(Continued from page 49A)

time bases, telemetering, and chronometry

This tuning fork requires 6, 12, or 28 volts, 3.6 watts, and 100 to 350 volts 0.008 ampere. Accuracy is 1 part in 100,000; temperature coefficient, better than 1 part per million per degree Centigrade from 0 to 85° C or better.

Copper Oxide Rectifier

A new copper oxide rectifier of **Bradley Laboratories, Inc.**, 82 Meadow St., New Haven, Conn., is designed to obtain a high reverse resistance of over 1 megohm per plate. The unit is intended for circuits in which very low leakage and maximum stability are essential.



Featuring vacuum processed gold contacts the new rectifier has 2½-inch leads. The rectifier barrel is only ⅝ inch long and ¼ inch in diameter. Model number is CX18. Rated up to 5 ma dc.

(Continued on page 57A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 56A)

Electrostatic Voltmeters

New electrostatic voltmeters, developed by **Cole Instrument Co.,** 1320 S. Grand Ave., Los Angeles 15, Calif., are offered in portable and panel types. They operate on the attraction or repulsion between two electrical surfaces, and are used to measure high voltage outputs where no current can be drawn.

They are useful in many plants for measuring static voltages, and to check the charge of capacitors, potential of cathode-ray tubes, circuits of television, radar, ionization chambers, radiation instruments, and similar equipment.

These instruments have double pivoted movements with strong springs. The mirrored scale is 5 inches long with hand-drawn divisions. The aluminum pointer has a knife-edge for close reading. The accuracy as stated, is 1 per cent of full scale value. The movement is shielded to avoid errors due to stray external fields.

The portable type shown is furnished in single ranges, full scale from 120 volts to 12,000 volts and multi-ranges from 120/240 to 1,000/3,000/7,500 volts.

TV-FM Sweep Generator

A new television-FM sweep generator and marker combined in one instrument is the latest addition to the "Tee Vee" line of test equipment made by **Radio City Products Co.,** 152 W. 25 St., New York 1, N. Y.

(Continued on page 58A)

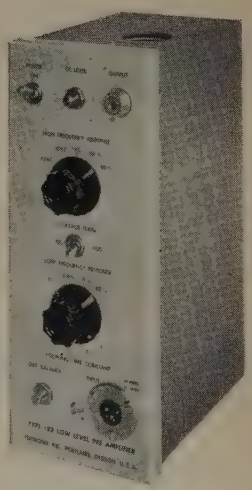
LOW FREQUENCY PULSE PHENOMENA

- *Band Pass—DC-2mc*
- *Sensitivity—5mv/cm maximum*
- *Sweeps—.3 sec/cm to 3 μsec/cm*

Type 512 Oscilloscope

Accurate observation and measurement of slowly recurring phenomena is difficult, if not impossible, by conventional oscilloscopic techniques. The Tektronix Type 512 Cathode Ray Oscilloscope, combining as it does direct-coupled amplifiers, slow sweeps and high accuracy, is recognized by a constantly increasing number of researchers as being an indispensable laboratory tool. New and fruitful approaches to the problems encountered in research are permitted by these features. *$950.00 f.o.b. Portland, Oregon.*

SUPPLEMENTARY SENSITIVITY



- *Gain—1000*
- *Band Pass—1/6cps-40kc*
- *Noise Level—10μv peak-to-peak, max.*

Type 122 Pre-Amplifier

The Tektronix Type 122 Pre-Amplifier has been designed as an accessory to the Type 512 Oscilloscope, for use in the biophysical, geophysical and other fields requiring additional sensitivity below 40 kc. At maximum gain, a 5 μv signal will produce a 1 cm deflection on the oscilloscope. Use of the differential input gives a rejection ratio of 90 db for unwanted signals. A maximum of 20 v (peak-to-peak) is available at the cathode follower output. Multi-position switches permit separate control of both ends of the pass band. Battery operated for minimum noise level. *$85.00 f.o.b. Portland, Oregon.*

Write today for detailed specification of Type 512, Type 122, and other Tektronix instruments.

TEKTRONIX INC.

TEKTRONIX, INC.

712 S.E. Hawthorne Blvd. Portland 14, Ore.

IT'S KINGS FOR CONNECTORS

Pictured here are some of the more widely used R. F. co-axial, U. H. F. and Pulse connectors. They are all Precision-made and Pressurized when required. Over 300 types available, most of them in stock.

Backed by the name KINGS—the leader in the manufacture of co-axial connectors.
Write for illustrated catalogs. Department "T"

KINGS Electronics
811 LEXINGTON AVE., BROOKLYN 21, N. Y.

Manufacturers of Radar, Whip, and Aircraft antennas
Microphone Plugs and Jacks.
Radar Assemblies, Cable Assemblies, Microwave and Special Electronic Equipment

ONE OF OUR
PRECISION PRODUCTS
FACSIMILE LEAD SCREW
28" LONG
12⅝" OF 96 PITCH THREAD
SHAFT DIAMETER 0.6250" ± .0002"
CONCENTRICTY THROUGHOUT .0003"

MANUFACTURERS THREAD GRINDING, INC.
P. O. Box 66 EATONTOWN, N. J. ASBURY PARK 1-1019

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

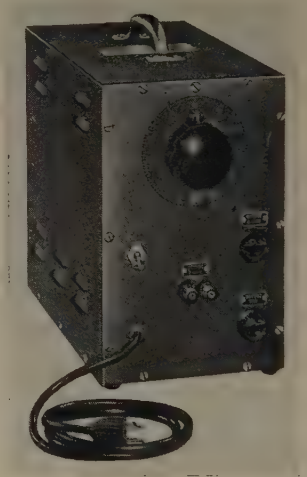
(Continued from page 57A)

The sweep generator uses an electromagnet type of sweep and two oscillator circuits. Design incorporates internal blanking circuit that permits retrace to be blanked out independently, regardless of the type of oscilloscope used.

Comprehensive range 5 to 240 Mc, continuously variable. Sweep width is variable from 400 kc to 10 Mc. Linearity is adequate for band-pass checking with an oscilloscope. Marker Range is 17 to 48 kc.

Adjustable AC Supply

A new voltage supply, called the "Solavolt," Type "CVL," is being manufactured by **Sola Electric Co.**, 4633 W. 16 St., Chicago 50, Ill.



Solavolts are designed for use with equipment that requires an adjustable source of constant ac voltage (from 0 to 130 volts) of undistorted wave shape. They provide all of the voltage stabilizing characteristics of the standard Sola constant voltage transformer . . . ±1 per cent regulation for line input changes from 95 to 125 volts, with less than 3 per cent harmonic distortion of the input voltage wave.

These Solavolt units may be used for exacting applications as well as general laboratory work, instrument calibration, testing, or other operations involving elements which are sensitive to power frequencies harmonically related to the fundamental.

As in other Sola constant voltage transformers, the voltage regulation is automatic and substantially instantaneous (maximum response time 1.5 cps). Except for the rotor of the autotransformer there are no moving parts, no manual adjustments, and no tubes or other expendable parts. Every unit is self-protecting against short circuit.

(Continued on page 59A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 58A).

50,000-Volt Power Supply

Condenser Products Co., 1375 N. Branch St., Chicago 22, Ill., has recently developed a 60-cps power supply to the following specifications: input voltage—117 volts ac, output voltage—50 kv: output current—1 ma (at 50 kv): output ripple—less than 1 per cent: output regulation:—4,000 volts per ma.

The distinguishing feature of the PS-50 is the ease by which the three 5825 rectifiers can be replaced. In other oil-filled supplies, the entire cover must ordinarily be removed to replace the tubes, or the carefully processed oil becomes contaminated. In the PS-50, the rectifier tubes are set in bakelite tube-wells. The oil in these tube-wells does not mix with the oil in the transformer-capacitor compartment. The spacings around the tubes are great enough so that they can be filled with unprocessed oil without danger of corona or flashover. The gasket-sealed covers on the tube-wells are easily removed.

There are separate connections for the filament and plate transformers so that an input variac may be used to change output voltage.

New Transformer Material

A new oriented silicon lamination which permits reduced transformer stacks with resultant savings in materials and weight is announced by the **Thomas and Skinner Steel Products Co.,** Indianapolis 7, Ind.

Main characteristic of the new lamination is higher permeability, with lower core loss. As a result, the oriented silicon material offers transformer designers greater efficiency with the normal number of E's and I's, or equal efficiency with fewer laminations.

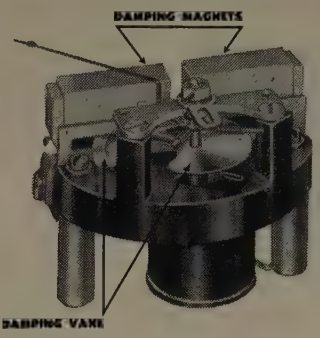
Performance curves indicate that stacks may be reduced as much as 50 per cent in some cases, with resultant savings on copper and weight.

The new oriented silicon laminations are available in standard E and I designs and sizes, as well as for special applications.

(Continued on page 60A)

FAST STOPS

MAGNETIC DAMPING



A NEW Burlington A. C. METER

These new A.C. instruments are *Magnetically Damped* by use of *Alnico Magnets* and are of the *Repulsion Vane Type* using carefully aged and impregnated field coils and multipliers. All standard ranges available in round, rectangular or square case styles and are guaranteed for one year against defects in workmanship or materials. Refer inquiries to Dept. I 80.

Burlington Instrument Co., Burlington, Iowa

ELECTRO-MECHANICAL RESEARCH, INC.

Specialists in High Quality, Sensitive Electronic Instruments

NOW AVAILABLE:

MODEL 33—Supersensitive, narrow band, ten-cycle Amplifier. Maximum voltage gain 175 db. Also MODEL 35A Optical Chopper.

MODEL 27A—Subcarrier Discriminator. A high precision instrument for use in FM/FM telemetering systems. Linearity of output vs. subcarrier frequency ±½% of full scale.

MODEL 36B—Broadband D-C Amplifier and sensitive voltmeter for use with oscilloscopes and recorders in a wide variety of physical and biological measurements.

MODEL 40A—Frequency Calibrator for rapid calibration of multi-channel FM system records.

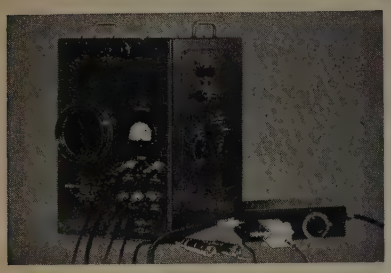
Manufacturing Consultants in the Fields of Infrared Devices, Metal Location, Vibration and Shock Measurement

Inquiries are invited on standard products and special services.

Electro-Mechanical Research, Inc.

RIDGEFIELD, CONNECTICUT

Test Equipment FOR RADAR and PULSE APPLICATIONS

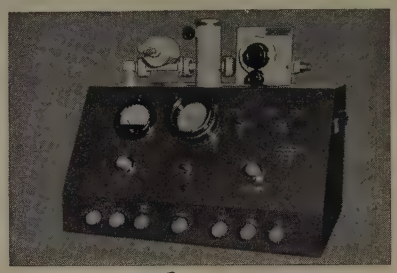


MODEL 705 WOBBULATOR

Swept signal output with center frequency adjustable from 2 to 500 mc.
Continuous swept output adjustable from 0 to 100 mc./sec. with 0.1 volt output at 50 ohms.
Internally synchronized scope with detectors and amplifiers.
High and low impedance shielded traveling detectors.
Output designed for making response measurements at 3000 mc., IF frequencies, and Video.

MODEL 708 SPECTRUM ANALYZER

Frequency range—8500 mc to 9600 mc.
Receiver—Double conversion superheterodyne.
IF bandwidth—approximately 10 kc.
Sweep frequency—10 cps to 25 cps.
Minimum frequency dispersion—1 mc/inch.
Maximum frequency dispersion—10 mc/inch.
Signal input attenuator—100 db linear.
Power—115V or 230V, 50 cps to 800 cps.

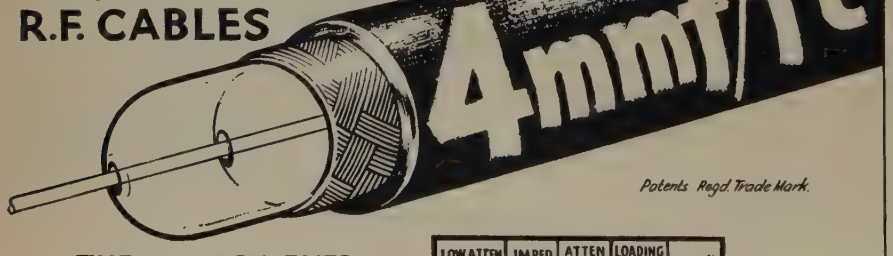


Write for complete technical data

Canoga Corporation

14315 Bessemer St., Van Nuys, Calif. • Box 361

Only with CO-AX air-spaced articulated R.F. CABLES



Patents Regd. Trade Mark.

THE LOWEST EVER CAPACITANCE OR ATTENUATION

We are specially organised to give **SPOT DELIVERIES TO U.S.A** *Cable your rush order for shipment by air freight. Settlement by your own $ check*

LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft at 100 Mc/s.	LOADING kw	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	
A 34	73	0.6	1.5	0.88	HIGH POWER FLEXIBLE
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	V.L.C. ★
C44	4.1	252	2.1	1.03	

★ *Very Low Capacitance cable.*

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD · LONDON SW7 ENGLAND
CABLES: TRANSRAD. LONDON.

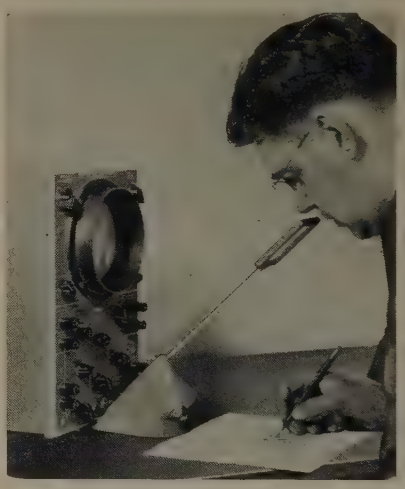
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

New Oscillo-Tracer

Robert A. Waters, Inc., 4 Gordon St., Waltham 54, Mass., announces the development of the Oscillo-Tracer, an optical super-positioning device that permits tracing of cathode-ray patterns of a repetitive nature directly on graph paper. The use of the Oscillo-Tracer for viewing oscillograms increases accuracy by the elimination of parallax caused by curved-face cathode-ray tubes and flat calibrated scales. The "projected" pattern is exactly the size of the original trace. For complete data, write to J. A. Macri, Robert A Waters, Inc.



440-Volt Rectifier Cartridge

A new line of high-voltage selenium rectifier cartridges has been developed by the **International Rectifier Corp.,** 6809 S. Victoria Ave., Los Angeles 43, Calif. The rectifier illustrated is rated at 440 volts dc and 10 ma dc, with a peak current rating of 120 ma and a peak inverse rating of 1,500, volts. The 440-volt rectifier is of the half-wave type and is 9/16 inch outside diameter with an over-all length of $1\frac{5}{8}$ inches. Its voltage drop at rated load is about 25 volts, and its weight is $\frac{1}{2}$ ounce.

These rectifier cartridges are available in either phenolic, glass, or hermetically sealed assemblies from $\frac{1}{4}$ to $1\frac{1}{4}$ inches outside diameter, or they can be built to individual specifications utilizing either the half wave, or voltage doubler circuit. High-voltage rectifier cartridges are finding wide applications for radar, sonar, oscilloscope, photoflash, and all types of high-voltage power supplies.

(Continued on page 61A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 60A)

Control Track Generator

It is now possible to use many of the non-synchronous ¼-inch magnetic tape recorders for picture-synchronous sound-track recording by employing a control tract generator, manufactured by the **Fairchild Recording Equipment Corp.**, 154 St. and Seventh Ave., Whitestone, N. Y.

This generator superimposes a high-frequency signal on the magnetic tape simultaneously with the sound track. The hf signal becomes the tape speed control during playback. When played back on a "Fairchild Pic-Sync Recorder" this control track compensates for tape stretch and shrink, maintaining lip-sync between sound-track-on-tape and the picture-on-film. No extra heads or modifications to presently owned tape recorders are required. This compact unit is supplied in a small carrying case and may be removed for rack mounting. Cannon plug receptacles at the rear of the $19\frac{3}{4}\times9\frac{1}{2}\times7\frac{3}{4}$-inch unit are for the two audio connections: one from the signal source, and one to the tape recorder's audio input terminal.

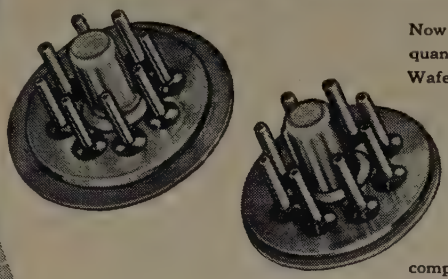
New Gamma-Ray Detector

The Model 939 Scintillometer (gamma-ray detector) has been announced by the **Halross Instruments Corp., Ltd.**, 171 Garry St., Winnipeg, Canada.

(Continued on page 64A)

E-I HERMETIC SEALING COMPONENTS

NEW! OCTAL PLUG-IN WAFERS



Now available in production quantities, E-I Series OBS Plug-in Wafers feature several important new developments. Hollow keys are form fitting and a new hermetic sealing technique makes the seal practically indestructible, even when the pins are bent. The entire assembly is extremely rigid. For complete data, call or write for the E-I illustrated brochure.

STANDARD SIZES	
MODEL	OUTSIDE DIA.
OBS 146	1.460
OBS 125	1.250
OBS 106	1.060

E-I INC ELECTRICAL INDUSTRIES INCORPORATED
44 SUMMER AVENUE • NEWARK 4, N. J.

200 MC BAND WIDTH AMPLIFIERS

Model 202P Wide-Band Chain Amplifier with Regulated Power Supply.

Band Width: 100 KC to 200 MC. Gain: 20 db.
Impedance: 200 ohms. Rise Time: Less than .003 usec.

With the Model 202P: very fast pulses, transients and other high frequency voltages can now be amplified.

With the Model 202P: vacuum tube voltmeters and oscilloscopes are ten times more sensitive.

With the Model 202P: the output voltage of signal, sweep and pulse generators is ten times greater.

Other Wide-Band Chain Amplifiers available:
Model 200A — 10 db Gain. Model 204 — 40 db Gain.

Makers of chain amplifiers, temperature controls, variable electronic filters and power supplies.
Write for Bulletin 202P-1-E

SKL SPENCER-KENNEDY LABORATORIES, INC.
186 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

MICROWAVE TEST EQUIPMENT

PULSE EQUIPMENT

G.E.K.—2745 ..... $39.50
G.E.K.—2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS $39.50
W.E. $D166173 Hi-Volt input transformer. W.E. impedance ratio 50 ohms to 900 ohms, Freq. range; 10 kc to 2 mc. 2 sections parallel connected, potted in oil $36.00
W.E. KS 9800 input transformer, Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. K2450A. Will receive 13 KV.4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E. $34.50
TPS10 Modulator X Band $350.00
SO-4 Radio Thyratron $425.00
SCR-268 Keyer units $95.00
715B Tubes $12.00
705A Tubes $2.80
705 Sockets ..... $.70

Complete line of high voltage pulse transformers, networks and dual lines.

23,000 TO 27,000 MC. BENCH TEST PLUMBING
½" x ¼" WAVEGUIDE

PRECISION SLOTTED LINE. DeMornay Budd type 337. complete with adjustable probe and crystal output. Square flanges. $400.00
PRECISION SLOTTED LINE. Adjustable probe. Humble Oil type. CPK-21HU $200.00
DIRECTIONAL COUPLER-WAVEMETER MOUNT. 12DB $60.00
PRECISION VARIABLE ATTENUATOR. mfg. Bernard Rice $90.00
TUNABLE CRYSTAL MOUNT. DB423 less tuning plunger $30.00
FLAP ATTENUATOR. DB405 10DB attenuation $25.00
LOW POWER LOAD $20.00
SCREW TUNER $25.00
SHUNT TEE $35.00
WAVEGUIDE LENGTHS. 2" to 6" long, gold-plated with circular flanges and coupling nuts ..... $2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS32 ..... $49.50
Mitered Elbow, cover to cover $4.00
TR-ATR Section, choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adaptor, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" ..... $1.00 per ft.
Circular Flanges ..... $.50
Flange Coupling Nuts ..... $.50
Slotted line, DeMornay Budd #397, new $450.00
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB ..... $49.50 ea.
K BAND 2K33 w/cav $115.00
3J31 Magnetrons $55.00

8500 Mc. to 9600 Mc. Bench Test Plumbing
1" x 1½" WAVEGUIDE

SLOTTED LINE. Complete with adjustable probe, crystal output, precision vernier adjust. Humble oil type $220.00
KLYSTRON MOUNTS. DeMornay Budd type DB380 for 2K25 etc. includes tunable termination $70.00
VARIABLE ATTENUATOR. DeMornay Budd type DB383. Maximum attenuation 35DB. $120.00
VARIABLE STUB TUNER. DB536. 180 degree phase shifting capability $70.00
FLAP ATTENUATOR. DB385. Maximum Attenuation 10DB $25.00
MAGIC TEE. DB539. ..... $42.00
WAVE GUIDE TO TYPE "N" ADAPTOR. DB377 ..... $15.00
LOW POWER TERMINATION. DB381 ..... $18.50
UNI-DIRECTIONAL COUPLER. DB390. 23DB type "N" output $18.50
PICK UP HORN. Type "N" output $4.50
WAVEMETER. 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type ..$85.00
WAVEGUIDE LENGTHS. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections ..... $2.00 per ft.
90 DEGREE ELBOWS. E or H plane, 2½" radius $12.50
MITERED ELBOWS. E or H plane $10.00
45 DEGREE OFFSET ELBOWS. E or H plane $10.00
90 DEGREE TWIST. 6" long $8.00
BULKHEAD FEED—THRU ASSEMBLY ..$15.00
PRESSURE GAUGE SECTION. 151b. gauge and press. nipple $10.00
PRESSURE GAUGE. 15 lbs. $2.50
CRYSTAL MOUNT. 1N23 type crystal holder $17.50
DUAL OSCILLATOR-BEACON MOUNT. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields $42.50
DUAL OSCILLATOR MOUNTS. (Back to back) with crystal mount, tunable termination, attenuating slugs $18.50
KLYSTRONS 723AB $12.00
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Broad Band Directional coupler, type "N" take off choke to cover, 23 DB calibrated $18.50
Flexible Section 18" long $12.00
Rotary Joint Choke to Choke $10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50
723AB Mixer-Beacon Dual Oscillator Mount Matching slugs and tunable termination, new ..$24.50

1¼" x ⅝" WAVEGUIDE

SLOTTED LINE. Complete with adjustable probe, crystal output, precision vernier adjust. Humble Oil type $225.00
TUNABLE TERMINATION. Precision adjust. $65.00
LOW POWER TERMINATION $25.00
MAGIC TEE $45.00
TRANSITION. 1¼" x ⅝" to 1" x ½" ..$19.50
OSCILLATOR MOUNT. for four 723AB klystron $38.50
90 DEGREE ELBOWS. E or H plane $12.50
WAVEGUIDE LENGTHS. Cut to size and supplied with 1 choke, 1 cover, per length ..$2.00 per ft.
WAVEMETER: Absorbtion type. Precision micrometer adjust. Very high Q $150.00

MAGNETRONS

2J27		
2J31	2J62	
2J21-A	3J31	
2J22	5J30	
2J26	714AY	
2J32	718DY	
2J37	720BY	
2J38	720CY	
2J39	725-A	
2J40	730-A	
2J49	728	
2J34	700	
2J61	706	

KLYSTRONS

723A 2K42
707B W/Cavity
417A 2K22
2K41 726B
2K26 2K55 726C

"CW" MAGNETRONS

QK 62 3150-3375 mc.
QK 59 2675-2900 mc.
QK 61 2975-3200 mc.
QK 60 2800-3025 mc.
QK 915

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$ 8.90
5200	21/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons ..... $24.50 ea.
GE Magnets type M7765115, GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1⅝". New Part of SCR 584 ..... $34.50

THERMISTORS

D-167332 (tube) ..$.95
D-170396 (bead) ..$.95
D-167613 (button).$.95
D-164699 for MTG in "X" band Guide $2.50
D-167018 (tube) ..$.95

VARISTORS

D-170225 .....$1.25
D-167176 .....$.95
D-168687 .....$.95
D-171812 .....$.95
D-171528 .....$.95
D-168549 .....$.95
D-168442 .....$3.00
D-165593 .....$1.25
D-98836 .....$2.00
D-161871A $2.85
D-171121 .....$.95
D-162356(308A) .$1.50
D-163357 .....$2.00
D-99946 .....$2.95

6000 Mc. to 8500 Mc. Bench Test Plumbing
1½" x ¾" WAVEGUIDE

KLYSTRON MOUNT. DB356 complete with shield and tunable termination $125.00
FLAP ATTENUATOR. DB361 ..... $45.00
PRECISION WAVEMETER. DB358. Micrometer adjust head $190.00
VARIABLE STUB TUNER $90.00
WAVEGUIDE TO TYPE "N" ADAPTER ..$18.50
WAVEMETER TEE. DB352 ..... $32.50
SLOTTED LINE. DB354 Precision vernier adjust. less probe $320.00
MAGIC TEE $80.00
DIRECTIONAL COUPLER. Two hole 25DB coupling, type "N" output $25.00
PRECISION CRYSTAL MOUNT. Equipped with tuning slugs and tunable termination ..$125.00
TUNABLE TERMINATION. Precision adjust $70.00
LOW POWER LOAD $35.00

4000 to 6000 mcs. Bench Test Plumbing
2" x 1" WAVEGUIDE

SLOTTED LINE. DeMornay type 332 complete with probe, etc. $600.00
FLAP ATTENUATOR $48.00
VARIABLE STUB TUNER AND LOW POWER TERMINATION $48.00
WAVEMETER TEE $48.00
ADAPTERS: Choke to choke $18.00
Cover to cover $14.00
Choke to cover $16.00
WAVEGUIDE TO TYPE "N" ADAPTER ..$45.00
DIRECTIONAL COUPLER. Two hole type, type "N" output $48.00
KLYSTRON MOUNT. Equipped with tunable termination and micrometer adjust, klystron antenna tuning $110.00
CRYSTAL MOUNT. Equipped with tunable termination and micrometer adjust crystal tuning $125.00
TUNABLE TERMINATION. Precision adjust $90.00

3000 MC BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type. Type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

R. F. EQUIPMENT

LHTR. LIGHTHOUSE ASSEMBLY, Part of RT-39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice .$47.50 ea.

S. BAND

90° Twist, circular cover to circular cover....$25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount, Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOORNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees ..... $75.00 per set
POWER SPLITTER: 726 Klystron input dual "N" output $5.00
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated ....$2.00 ea.

⅞" RIGID COAX

Magnetron Coupling with TR Loop, gold-plated $7.50
Sperry Rotating Bend, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length $7.50
Short Right Angle Bends (for above) $2.50

GENERAL TEST EQUIPMENT

Multi Frequency Generator. American Time Product type SC-16. Frequency 10 to 190. Precision Standard "Watch-Master"
UHF Signal Generator R.C.A. type 710A 370 to 560 mcs.
Wheatstone Bridge. Industrial Instruments type RN-1
FM Signal Generator. Boonton Radio type 155A Freq. range 1 to 10 mcs., 38 to 50 mcs.
Condenser Weld Power. Cap. 56 mfd. max., max. chg. 1500 Volts
Frequency Meter. Lavoie Model 105-300 to 600 mcs.
Megohm Bridge. Industrial Instruments type MB.
Visual Alignment Signal Generator. General Electric—0 to 60 mcs.

NEW TEST EQUIPMENT IN STOCK

I-185A Oscillator
I-158 Range Calibrator
I-223 Range Calibrator
BC 438 Freq. Meter
RF Preamp.
G.R. Capacity Brdg. #216
G.R. Uni Galvo Shunt #229
G.R. 100 SL Aud. Osc. #213
TS226A/AP Pwr. Mtr. 0-1000 W.
Sig. Gen. #804 8-330 MC
183J Dynamotor Test set

WRITE PHONE FOR DATA AND PRICE

ARMY-NAVY TEST SETS

TS-226A/AP Power Meter.
TS62/AP 3 centimeter precision echo box.
TS36/AP 3 centimeter Thermistor Bridge—Power Meter.
TS89/AP Voltage divider.
TS268/U Crystal checker for IN23 type crystals etc.
CW-60ABM 10 Centimeter Wavemeter. Coaxial type micrometer adjust cavity, Resonance indicating meter, carrying case (similar to TS117/GP)
TS235/UP High Power Load, "L" band (1000 mcs.)
LU-1 Freq. Meter and Test OSC. Type CRV-60ACL
TVN-9HU Power Supply. M.I.T. Rad. Lab.
TVN-8SE Klystron Power Supply. M.I.T. Rad. Lab.
CS60ABW Watt Meter—Wavemeter. 3 centimeter.
APR5 Receiver—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC input.

TEST EQUIPMENT

Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line New $425.00
SO-3 Receiver, 30 mc. IF. 6 stages 6AC7. 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc in ch. 13 vol. 23 M.I.T. Rad. Lab. Series $99.50
APS-2 10 CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser, 714 magnetron 417A Mixer all ⅞" rigid coax, incl. revr. front end $210.00
10 cm. cavity type wavemeters 6" deep, 6½" in diameter Coax. Output Silver Plated ...$64.50 ea.
10 cm. echo box. Part of SFI Radar W/115 volt DC Tuning motor Sub Sig. 1118AO $47.50

All merch. guar. Mail orders promptly filled. All prices, F.O.B., N.Y.C. Send Money Order or Check. Only shipping charges sent C.O.D. Rated Concerns send P.O.

COMMUNICATIONS EQUIPMENT COMPANY

131 LIBERTY STREET, NEW YORK, N.Y. DEPT 18 P. J. PLISHNER PHONE DIGBY—9-4124

QCQ2 SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use: Medium ASW ships.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards, and manual.
Projector. Magnetostrictive, permanent magnet polarization, resonant frequency about 25 kc.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located the output tubes and the high voltage rectifier. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned-radio-frequency type. It includes time varied gain, to reduce the volume of reverbrations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note above or below 800 cycles.
Keying and indicating system. Keying is mechanical; cams in the indicator unit determine the pulse length and keying interval. Ranges are indicated by the flash of a neon lamp.
Complete sets available less hoist. Also stacks alone.

QBF and QJA SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use. Large ASW ships.
ABF may be converted by field modifications, to QJA available.
Keying interval. 1,000, 2,000, 3,000, 4,000, 5,000 10,000 yards and manual.
The electrical train system consists of a handwheel on the stack which selects, by commutation, three voltages from the secondary of a transformer-like device called a Commutator Transmitter.
Projector. The projector is of the Rochelle salt crystal type with a single element used for both listening and ranging. The frequency is 22 to 28 kc.
Transmitting system. The receiver-driver oscillator unit contains two electron tube oscillators, one fixed at about 150 kc and one tunable over the range from 160 to 180 kc. The outputs of the two are mixed, producing a difference frequency, which is then fed to the driver-amplifier unit and thus to the projector.
Receiving system. The receiver is a superheterodyne type covering the range from 10 to 30 kc.
Keying and indicating system. Ranges are indicated by the flash of a neon lamp which revolves at a constant speed, driven by a synchronous motor.

QCU, QCU-1 SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use. Small ASW Ships.
Intended to be used as a replacement for the obsolete WEA-1 equipment the old hoist.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards and manual.
Training is electrical, controlled by a hand crank at the remote station.
Projector. Magnetostrictive, permanent magnet polarization, resonant frequency about 25 kc, split for BDI.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located two type 811 output tubes and two type 836 high voltage rectifier tubes. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned radio frequency type. It includes time varied gain, to reduce the volume of reverberations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note, above or below 800 cycles.

QCS, QCS-1, QCT-1 SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use. ASW ships.
Keying interval (original)—1,000, 2,000, 5,000, 10,000 yards and manual. (field modification added 3,000 and 4,000 yards)
Transmitting system. The driver-rectifier unit contains an electron-tube oscillator tunable over the range of 17 to 25.5 kc, and electron-tube amplifier and a rectifier power supply.
Receiving system. The superheterodyne receiver covers the range from 13 to 37 kc and may be connected by a selector switch to either the "QCQ" or the "JK" face of the projector. It has separate audio amplifiers for the range indicator lamp and for the loudspeaker. The audible note may be adjusted over the range from 0 to 1600 cycles. Three degrees of i-f selectivity and two of audio are provided by selector switches connected to filters.
Keying and indicating system. Keying is mechanical; cams driven by the range indicator disc shaft determine the pulse strength and keying interval.

Complete 3 CM Radar System Equipment
40 KW peak transmitter, pulse modulator, receiver, using 723AB, power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, all tubes, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

High Voltage Power Supply
15 KV at 30 Ma DC, Bridge Rectifier, Western Electric ..$125.00

RADIO SYSTEMS

TAJ 500 Watt Low Frequency Transmitter 150-550KC CW-MCW.
TBK 500 Watt High Frequency Transmitter 2-18 MC. A1, A2, A3, Emission Mfg. by RCA.
White Radio Telephone Model #WRMSS—ship to ship—ship to shore—small airports—mines—plantations—inter island—ranches. 10 channel fix tuned rec. & xmitter. Xmittr. pwr. output in excess of 100W unmodulated into antenna of 18Ω & 100 MMF. Freq. Range 2-12 MC. Can be modified to increase range. Xtal controlled. 110V 60 cy or 220V 60 or 25 cy. Meas. 24" H x 19" WX 14" D. 125 lbs. Write or phone for data.

FM STATION

Kilowatt Amplifier
Model 4BT2A1 Type BT2A Serial RC25
250 Watt Exciter
Model 4BT1A1 Type 3T1A Serial CC833
Station Monitor
Model 4BM1A1 Type BM1A Serial WC268
Power Supply
Model BP241 Type BF2A Serial WC547
Transmitter Console
Model 4BC3A1 Type BC3A Serial WC5
Type BX-2A Two Bay Circular Antenna with Mast, Transmission Line, Elevators and Matchers.
100 Feet of 1⅝ coax transmission line including 90° elbows.
Dehydrator for transmission line.
Desk and Chair for transmitter console.

Write or Phone for Data and Price

APS-2 10 cm. airborne radar set designed for navigation and high altitude bombing. The antenna rotates through 360 degrees. Presentation is PPI and A Scope. The following units of the set are supplied: Antenna, transmitter-receiver, modulator, indicator, 24VDC input power unit. New with all tubes, incl. 714AY magnetron, 417A klystron.

APS-3 3 cm. airborne radar set designed for intercept of enemy aircraft and nominal navigation. Antenna is sector scan. Remote as well as master indicator is supplied. 725A magnetron operates the set at 45kw. Complete sets available with all tubes incl. magnetron and 723AB klystrons. Both new and used condition.

APS-4 cm. airborne radar set designed for sector scan surface search, mapping and navigation, weather forecasting intercept of enemy aircraft. Entirely enclosed in a streamlined housing for optional mounting on aircraft bomb rack, or on nose of large bombers. Complete sets with indicator equipment, and power unit ready for installation.

APS-6 3 cm. Night Fighter radar with pencil beam antenna. Transmitter-receiver packages and antennas available in equal to new condition.

APS-6A 3 cm. airborne radar RF package, 45kw, using 725A magnetron, IF strip using 6AK5's, 723AB beacon and local oscillator.

APS-10 3 cm. airborne radar using 2J42 magnetron. Modulator decks and low voltage power supply, only, available, less tubes. Beacon—local oscillator klystron mounts are available.

APQ-13 3 cm. airborne radar complete RF package in excellent condition including all tubes.

APS-15 3 cm. airborne radar designed for high altitude bombing, navigation, intercept of enemy aircraft, weather forecasting. Antenna rotates 360 degrees. Presentation is PPI and A Scope. The following units are supplied: Antenna, transmitter-receiver, modulator, indicator, slant-range computer, 24VDC input power unit. New with all tubes including 45kw 725A magnetron. 723AB local oscillator-beacon.

CPN-8 10 cm Navigation Beacon ground station. Complete and partial installations available. High power beacon of long range capability. Complete power, frequency, operation analyzer (5" scope) included.

CXBR 10 cm. M.I.T. navigation beacon equipment, complete, in excellent condition.

FD MARK IV 800 mc. gunlaying radar mfg. and designed by Western Electric for battleships. Complete consoles available with all tubes including 700A magnetron and modulator thyratron.

MARK 10 10 cm. gunlaying radar, complete, for automatic firing of guns as antenna tracks target. 250 KW.

SA 200 cm. Air Search radar especially designed for shipboard of mobile installation. Ideal for ground intercept and control of aircraft. PPI 7" indicator. Long range.

SD 200 cm. radar similar to SA but designed for installation on submarines. New.

SE 10 cm. shipboard Surface Search radar, using thyratron modulator. Complete installation available including spare parts. "A" scope presentation. 250 KW.

SF-1 10 cm. shipboard Surface Search radar with PPI and A scope. Used for navigation and target range information on naval vessels. 250 KW.

SG 10 cm. shipboard Surface Search radar with PPI and A scope. Heavy, rugged equipment designed for large naval and merchant vessels. 250 KW.

SJ-1 10 cm. radar designed for installation of Submarines. Equipped with PPI and A scope. Complete installations.

SL 10 cm. radar designed for Surface Search on shipboard. PPI indicator console.

SN 10 cm. portable radar. Lightweight, easily transportable complete radar installation using lighthouse tubes with a 25 mile maximum range. 115 V AC operation.

SO-1 10 cm. shipboard radar for navigation of all types of vessels. 4, 20, and 80 miles range. PPI indicator. Large antenna. 115 V DC input.

SO-8 Same as SO-1 but with a lightweight antenna.

SO-13 Same as SO-1 but with a lightweight antenna, 28 V DC input. Designed for PT boat installation.

SCR-518 Radar altimeter using pulse-echo-time principle, 400 mc, 28 V DC input, CR tube altitude indication.

SCR-520 Airborne radar RF package, 10 cm., complete with pulser, 714AY magnetron.

SCR-533 IFF/Air Search trailer, complete, 500mc operation, A scope.

SCR-663 Sperry searchlight training, aircraft tracking ground installation. Used condition.

TPS-2 1000 mc. portable early warning system. Bed spring antenna. Complete with portable gasoline generator.

UPN-2 10 cm. portable beacon equipment.

SQ 10 cm. portable radar designed for use on landing barges and beach heads. PPI, B. A indication on 3" scope. 115V AC operation.

MORE TEST EQUIPMENT

TS 36, 110AP 35, 62, 108, 102, 111, 34, 104, 45, 102, 33, 107, 16

RADAR RADAR RADAR RADAR

R A D A R

RADAR RADAR RADAR RADAR

COMMUNICATIONS EQUIPMENT CO.

131 Liberty Street, New York, N.Y.

Dept. 18 **P. J. Plishner** **Phone Digby—9-4124**

The Q METER
TYPE 160-A

ACCURATE • DEPENDABLE • VERSATILE

For the measurement of Q, inductance, and capacitance, the 160-A Q-Meter is the universal choice of radio and electronics engineers. Its wide frequency coverage from 50 kc. to 75 mc. is an outstanding feature which makes possible the accurate and rapid evaluation of components and insulating materials at the actual operating frequency.

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 50 kc. to 75 mc. 8 self contained ranges.
OSCILLATOR FREQUENCY ACCURACY: ±1%, 50 kc.-50 mc. ±3%, 50 mc.-75 mc.
Q-MEASUREMENT RANGE: Directly calibrated in Q, 20-250. "Multiply-Q-By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q-range to 625.
Q-MEASUREMENT ACCURACY: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.
CAPACITANCE CALIBRATION RANGE: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf. whichever is greater. Vernier capacitor section +3 mmf., zero, -3 mmf. calibrated in 0.1 mmf. steps. Accuracy ±0.1 mmf.

Write for literature containing further details

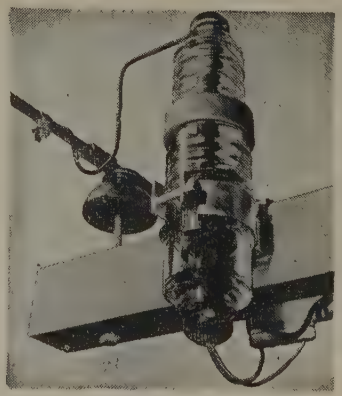
BOONTON RADIO Corporation
BOONTON·N·J·U·S·A·

S·S·White MOLDED RESISTORS
The "All-Weather" Resistors

ARE USED IN HIGH VOLTAGE "HIPOT" COUPLERS

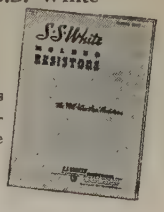
S.S.White resistors are connected in series to permit a current flow to ground, when the "Hipot" Coupler is used to measure or to synchronize voltage of high voltage lines.

Canadian Line Materials, Ltd.—maker of "Hipot" Couplers and other transmission, distribution and lighting equipment—says—"We have always found S.S. White resistors of the highest quality". This checks with the experience of the many other producers of electrical and electronic equipment who use S.S. White resistors.



S.S.WHITE RESISTORS are of particular interest to all who need resistors with *low noise level* and *good stability* in all climates.
HIGH VALUE RANGE
10 to 10,000,000 Megohms
STANDARD RANGE
1000 Ohms to 9 Megohms

WRITE FOR BULLETIN 4906
It gives details of S.S. White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.



S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT. GR 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS
One of America's AAAA Industrial Enterprises

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 61A)

The new instrument employs the scintillation principle, and provides a detection sensitivity over 100 times that obtainable by conventional portable Geiger counters; the actual count rate, the manufacturer claims, being approximately 290 times that of three popular Geiger counters tested under identical conditions.

Through the use of a gamma-ray spectrometer feature, the Scintillometer may be used to distinguish the difference between thorium and uranium ore deposits, and will indicate the uranium concentration in an ore containing both radioactive-minerals.

The Scintillometer employs high vacuum tubes in conservatively designed circuits; is protected against vibration, shock, temperature, and humidity; and will operate continuously between −20° F and +110° F with a relative humidity of 95 per cent.

A removable probe is contained in the lower section of the case proper.

Pocket-Size Sound Level Meter

Indoor and outdoor acoustics, machinery noise, and hearing requirements are quickly and accurately measured with the new Type 410-A miniature sound level meter, which has been developed by, **Hermon Hosmer Scott, Inc.,** 385 Putnam Ave., Cambridge 39, Mass.

Subminiature tubes and hearing-aid batteries permit a rugged compact design meeting all specifications of the American Standards Association for sound level meters.

This type 410-A, sound level meter, weighing slightly over 2 pounds, covers the range from 34 to 140 db above the standard ASA weighting characteristics which duplicate the ear response at various loudness levels. Readily available batteries have a normal operating life of 50 hours. Optional accessories include carrying case, extension cable with input adaptor, and mounting tripod. Vibration pickups and integrators are available for measurement of displacements, velocities, and accelerations in the audio-frequency range.

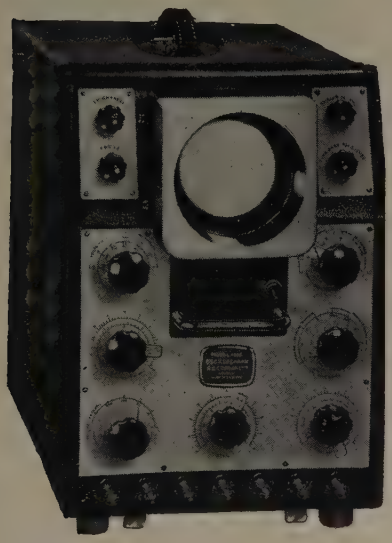
(Continued on page 65A)

COSSOR for QUALITY

TWIN BEAMS

THE *RIGHT* ANSWER . . .

for simple, accurate and convenient measurements. Simultaneous error-free comparison of voltages, currents, phases, frequencies, waveshapes.



THE COSSOR MODEL 1035

Twin Beam Oscilloscope

$650 f.o.b. New York

$465 f.o.b. Halifax

DIRECT READING calibrated time and voltage measurement controls. Continuously variable driven and recurrent sweeps from 150 millisec. to 5 microsec., blanked flyback.

Independent Y axis AC amplifiers for each beam + or — sync.

Flat face 4″ twin beam CRT, green, blue or long afterglow screens all available from stock.

* Write for complete specifications and data on Model 1049 DC amplifier scope, Model 1428 Camera and film drives.

AGENTS THROUGHOUT U. S. & CANADA

COSSOR (CANADA) LIMITED

Windsor St., Halifax, Nova Scotia

★

BEAM INSTRUMENTS CORP.

Room 208, 55 W. 42nd Street, New York 18, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 64A)

Incremental Inductance Bridge and Associated Accessories

The **Freed Transformer Co., Inc.**, 1718-36 Weirfield St., Brooklyn 27, N. Y., has introduced a new Incremental Inductance Bridge No. 1110.

This bridge is an instrument for accurate testing of communication and television components under load conditions. It has an impedance range of 1 millihenry to 1,000 henries in five ranges. The inductance values are read directly from a 4-dial decade and multiplier switch. The range of this instrument can be extended to 10,000 henries through the use of an external resistance.

The inductance accuracy of this bridge is within ±1 per cent through the frequency range from 60 to 1,000 cps. For the largest multiplier at 1,000 cps, the accuracy of the bridge is decreased to 2 per cent. A 50- or 60-cps line frequency is generally used with this bridge.

The controls are two 4-dial decades, one for inductance, and one for ac resistance, and a 5-position multiplier.

Additional recommended accessories are ac supply No. 1180, dc supply No. 1170 null detector No. 1140, or vacuum-tube voltmeter and null detector No. 1210.

For further information, catalog, and price lists, write directly to the manufacturer.

Improved Coaxial Tube

Precision Tube Co., 3824 Terrace St., Philadelphia 28, Pa., announces a new and improved coaxial tube known as "Coaxitube."

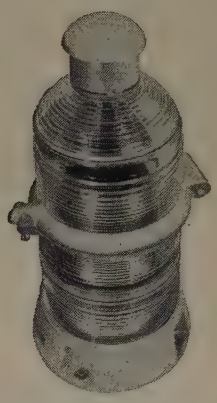
The Coaxitube consists of an inner conductor, dielectric, and a seamless tube forming a coaxial pair of conductors. Since the dielectric is continuous and the outer conductor is seamless, conductor and shield remain coaxial even when formed into intricate shapes. This feature is a great advantage for many circuit components, such as closely-coupled tank coils and grid feedback circuits, shielded grid leads, and high-frequency transmission lines. The dielectric can be polyethylene, DuPont Teflon, fibreglas, or any other material commercially available to give the required electrical performance.

(Continued on page 66A)

Dependable PERFORMANCE at LOWER COST

H&P TOWER LIGHTING EQUIPMENT

H & P lighting equipment, consistently specified by outstanding radio engineers, is furnished as standard equipment by most leading tower manufacturers.

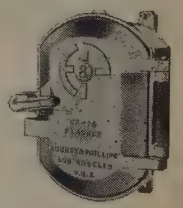


300 MM CODE BEACON

Patented ventilator dome circulates the air, assures cooler operation, longer lamp life. Concave base with drainage port at lowest point. Glass-to-glass color screen supports virtually eliminate color screen breakage. Neoprene gaskets throughout. CAA approved

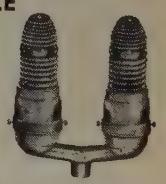
MERCURY CODE FLASHER

Lifetime-lubricated ball bearings. No contact points to wear out. Highest quality bronze gears Adjustable, 14 to 52 flashes per minute



SINGLE and DOUBLE OBSTRUCTION LIGHTS

Designed for standard A-21 traffic signal lamps Prismatic globes meet CAA specifications.



"PECA" SERIES PHOTO-ELECTRIC CONTROL

Turns lights on at 35 f.c.; off at 58 f.c., as recommended by CAA. High-wattage industrial type resistors. Low-loss circuit insulation.

ALSO COMPLETE LIGHT KITS FOR A-2, A-3, A-4 and A-5 TOWERS

PROMPT SERVICE and DELIVERY

First-day shipments out of stock. Immediate attention to specifications and unusual requirements.

WRITE OR WIRE FOR CATALOG AND DETAILED INFORMATION

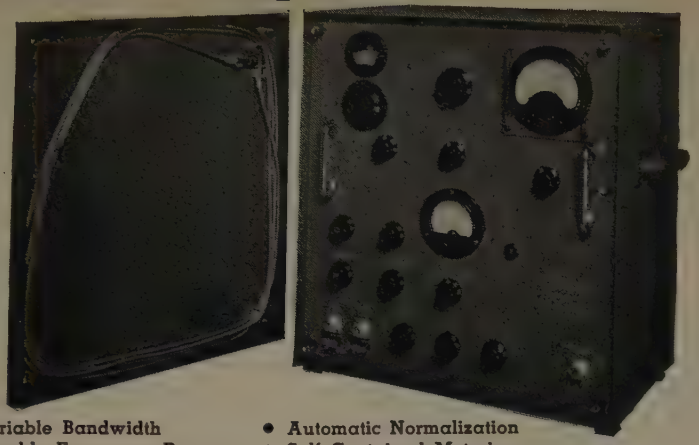
HUGHEY & PHILLIPS

TOWER LIGHTING DIVISION

326 N. LA CIENEGA BLVD LOS ANGELES 48, CALIF

60 E. 42ND ST. NEW YORK 17, N. Y.

Bolometer Amplifier . . .



- Variable Bandwidth
- Tunable Frequency Range
- Voltage Ratio Expander
- Automatic Normalization
- Self Contained Metering
- Recorder Output

USES

The P & B Bolometer Amplifier Model 100 is a quality amplifier designed for use in connection with making electrical measurements of antennas and associated radio-frequency systems. Standing wave ratios may be quickly determined on either a linear or expanded indicating scale.

The tunable, variable bandwidth, band-pass characteristics of the amplifier makes it useful where conditions might render other test equipment useless.

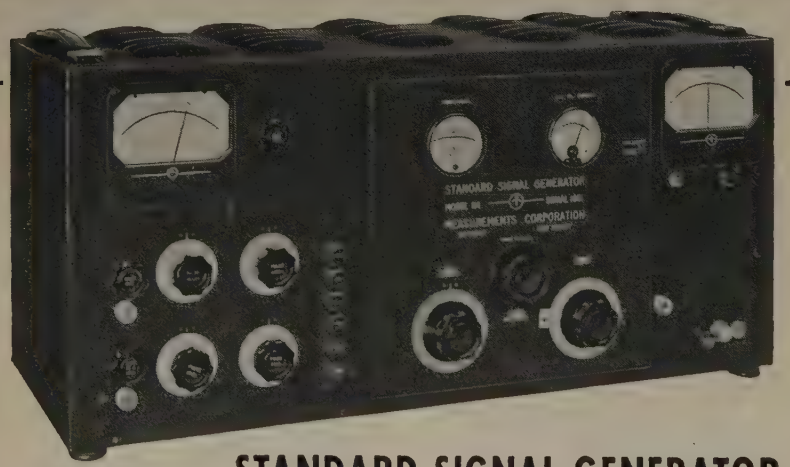
Built to Navy Specifications for research and production testing.

Ask for Bulletin L-100

CHARACTERISTICS

Frequency range—400 cycles—5000 cycles (± 3% calibration accuracy)
Bandwidth—(1/2 voltage) 6, 12, 22, 50, 100 and 300 cycles
Input Voltage Range
Signal Channel—10^{-2}—10^{-7} volt.
Monitor Channel—10-2-10-5 volt.
Expander Operation—10-2—10-5 volt.
Input Impedance—250-350 ohms.
Meter—logarithmic scale with 100 db decade.
Recorder Output—.01—100 volts @ .01 w. max. (undecaded)
Normalization—output voltage holds within 1/4 db for input changes of 5 db to both channels.
Bolometer Bias—adjusted in steps of 5% current change over range of 2.1.
Voltage Ratio Expander—8th power expansion.

PICKARD & BURNS, INC.
240 Highland Avenue — Needham 94, Massachusetts



STANDARD SIGNAL GENERATOR

MODEL 84—300-1000 Megacycles

OUTPUT VOLTAGE: Continuously variable from 0.1 to 100,000 microvolts. Output impedance, 50 ohms.

MODULATION: Sine Wave: 0-30%, 400, 1000 or 2500 cycles. Pulse: Frequency, 60 to 100,000 cycles. Width, 1 to 50 microseconds. Delay, 0 to 50 microseconds. Sync. output, up to 50 volts, either polarity.

POWER SUPPLY: 117 volts, 60 cycles. (Also available for 117 volts, 50 cycles; 220 volts, 60 cycles; 220 volts, 50 cycles.)

DIMENSIONS: 12" high x 26" wide x 10" deep, overall.

WEIGHT: Approximately 135 pounds, including external line voltage regulator.

Laboratory Standards

Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Grid-Dip Meters
Television and FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON · NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 65A)

Television Oscilloscope

A new high-gain, wide-band cathode-ray oscilloscope designed particularly for television circuit applications has been announced by the **Radio Tube Div., Sylvania Electric Products Inc.,** 1740 Broadway, New York 19, N. Y.

The new Type 400 oscilloscope, which is supplied with 7-inch Type 7JP1 green screen cathode-ray tube, provides vertical sensitivity of ten millivolts per inch, and vertical response useful up to 4 Mc.

The Type 400 provides linear sweeps ranging from 10 cps to 50 kc, 5-megohm, 26-$\mu\mu$f input impedance for negligible circuit loading which is suitable for any crystal, direct or special probe or with supplied lead; cathode follower input circuit; switching for direct connection to deflection plates; panel connection for intensity or Z-axis modulation; built-in 60-cps voltage source; and low-parallax cross-lined screen.

Air Flow Switch

A new improved vane-type air flow switch for use in forced air cooling of electronic equipment has been announecd by **Coral Designs, Div. Henry G. Dietz Co.,** P. O. Box 248, Forest Hills, N. Y.

The quantity of air required for forced-air-cooled tubes is specified for various types of service and often for various power levels. The 103-A, vane-type air flow switch, is designed to operate a control relay to guard against tube failure in the event of blower failure or air-passage obstruction.

It guards against air flow failure due to: dust precipitation blocking the air ducts caused by the tube radiators operating at high voltage, unclean air filter or obstructions blocking louvers in cabinet, stalling of the blower motor, etc. It will operate on a minimum velocity of 500 feet per minute. Electrical ratings of 5 amperes at 250 volts ac are Underwriters' Laboratories approved.

(Continued on page 67A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 66A)

High-Frequency Step Attenuator

A step attenuator, designed to cover the frequency range from dc to 1,000 Mc, is available from **Weinschel Engineering Co.**, 123 William St., New York 7, N. Y.

This attenuator contains coaxial pads. The resistance elements of each pad consist of stable, aged metal alloy films on pyrex glass.

A set of pads is mounted on a drum which is rotated to align any pad with a pair of matched, coaxial switches. Three drums are mounted on one panel. Each drum through its switches and associated cables connects to a separate pair of female-type "N" connectors located on the front panel.

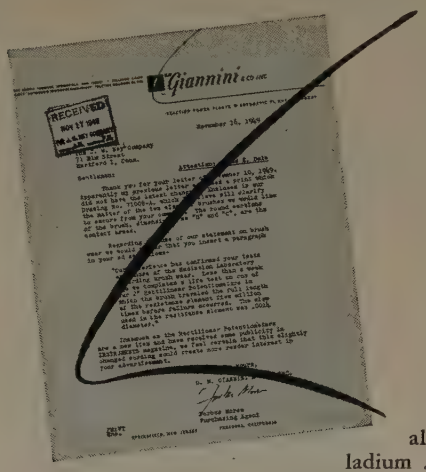
The calibration is unaffected by operation at relative humidities as high as 95 per cent.

At 60 Mc, the attenuation departs less than +0/2-per cent from dc attenuation. At 1,000 Mc, the range is 5 to 60 db, and attenuation departs less than +5/10 per cent from dc attenuation.

Zero insertion loss of each drum is less than ½ db.

(Continued on page 68A)

Manufacturer's tests confirm superiority of PALINEY* #7 for brushes on new Rectilinear Potentiometer . . .



"Our experience has confirmed your tests and those of the Radiation Laboratory regarding brush wear. Less than a week ago we completed a life test on one of our 2" Rectilinear Potentiometers in which the brush traveled the full length of the resistance element five million times before failure occurred. The wire used in the resistance element was .0014 diameter."

PALINEY* #7 . . . a precious metal alloy containing gold, platinum and palladium . . . is giving outstanding service as the sliding contact in many types of potentiometers where long life, low noise and maintained linearity are essential. This and other Tested NEY Precious Metal Alloys are also being used successfully in numerous precision contact and slip ring applications requiring controlled wear resistance, high conductivity and freedom from tarnish and corrosion. Write or call our Research Department for additional technical data, outlining your problem if possible.

THE J. M. NEY COMPANY 171 ELM ST., HARTFORD, CONN.

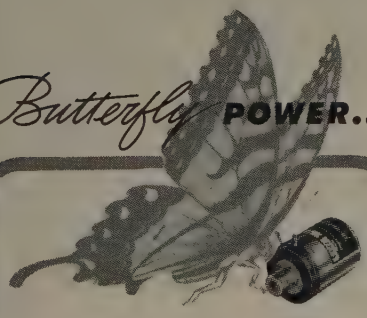
SPECIALISTS IN PRECIOUS METAL METALLURGY SINCE 1812

** Reg. T.M. J. M. Ney Co.*

G. M. GIANNINI & CO., INC.
697 Morris Turnpike
Springfield, New Jersey

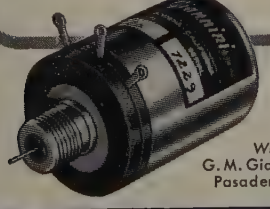
5NY50

Butterfly **POWER...**



• MICROTORQUE Variable Resistors and Potentiometers require as little as .003 in. oz. torque to operate. This unique feature makes the MICROTORQUE invaluable for applications where the position of instrument pointers, gyroscopes, and delicate instruments in general must be recorded, transmitted or indicated at a distance, and Giannini are the sole makers of MICROTORQUE Potentiometers.

A variety of resistance values and circuits available.



Write for booklet.
G. M. Giannini & Co., Inc.
Pasadena 1, California

giannini

USES

- Ultrasonic Vibration Measurements
- Harmonic Analysis
- Cross Modulation Studies
- Noise Investigations
- Determining Transmission Characteristics of Lines and Filters
- Monitoring Communications Carrier Systems
- Checking Interference, Spurious Modulation, Parasitics, Effects of load changes, shock, humidity, component variations, etc. upon frequency stability
- Telemetering

SPECIFICATIONS

Frequency Range: 2KC—300KC stabilized linear scale

Scanning Width: Continuously variable from 200KC to zero

Four Input Voltage Ranges: 0.05V. to 50V. Full scale readings from 1 millivolt to 50 volts

Amplitude Scale: Linear and two decale log

Amplitude Accuracy: Within 1db. Residual harmonics suppressed by at least 50db.

Resolution: Continuously variable. 2KC at maximum scannning width, 500c.p.s. for scanning widths below 8KC

WRITE NOW For Complete Information, Price and Delivery

Available Now!

Easy, Fast

Ultrasonic Spectrum Analysis

WITH

MODEL SB-7

PANORAMIC

ULTRASONIC ANALYZER

An invaluable new direct reading instrument for simplifying ultrasonic investigations, the SB-7 provides continuous high speed panoramic displays of the frequency, amplitude and characteristics of signals between 2KC and 300KC. The SB-7 allows simultaneous observation of many signals within a band up to 200KC wide. Special control features enable selection and highly detailed examination of narrower bands which may contain signals separated by less than 500c.p.s. The instrument is unique in that it provides rapid indications of random changes in energy distribution.

6
CONNECTOR TYPE SERIES for LOW LEVEL SOUND

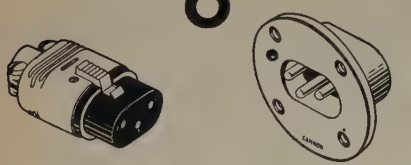
Cannon Plugs

UA

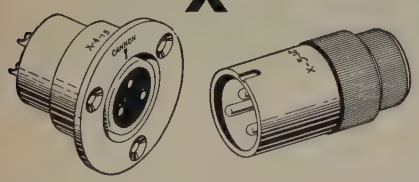
XL

P

O



X



XK

Address Cannon Electric Development Co., Division of Cannon Manufacturing Corporation, 3209 Humboldt Street, Los Angeles 31, Calif. Canadian office and plant: Toronto, Ontario. World export: Frazar & Hansen, San Francisco.

SINCE 1915
CANNON ELECTRIC

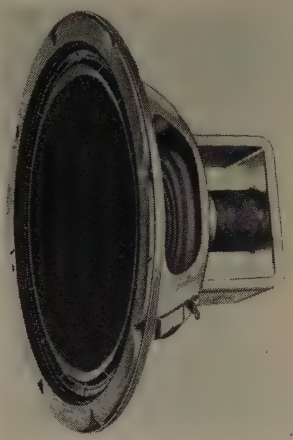
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 67A)

High-Fidelity Speaker

A new 8-inch high-fidelity speaker, Type 8T8-1, has been announced by **Permoflux Corp.**, 4900 W. Grand Ave., Chicago 39, Ill.



This new blue cone is claimed to have ideal response, and if properly baffled compares favorably with 12-inch speakers on the market today.

(Continued on page 69A)

The New STAVER
MINI-SHIELD
TRADE MARK REG. AND PAT. PEND.

The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5½ and T6½ bulb tubes. Send for catalog sheet.

THE Staver COMPANY
INCORPORATED
91 PEARL ST. • BROOKLYN 1, N.Y.
ULSTER 5-6303

Gold Plated
TUNGSTEN
and
MOLYBDENUM
GRID WIRE

Made to meet your specifications . . . for gold content, diameter and other requirements.

Write for details and list of products

SINCE 1901

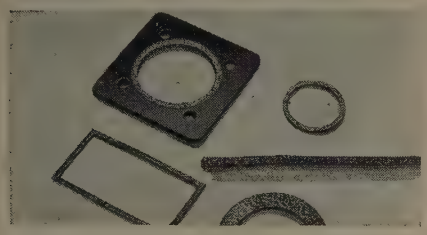
SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

ADVERTISEMENT

HF and UHF power leakage positively and economically controlled by new gasket material

The unique combination of controlled resiliency, stability and conductivity found in Metex "Electronic Weather Stripping" makes it particularly effective as a shielding material for such electronic applications as radar equipment, high frequency heating, television broadcasting and high frequency communication.

It is available in strips or in die-formed gaskets of the shape, size and volume required by the particular application. Economical in cost, the use of this material permits further savings in assembly time and eliminates much costly machining of closure surfaces that would normally be required.



Metex "Electronic Weather Stripping"

The base material is a knitted—not woven—wire mesh which is made from any metal that can be drawn into wire. Knitting produces a mesh consisting of a multiplicity of interlaced loops which increase the normal resiliency of the wire and, by their hinge-like action, permit freedom of motion without loss of stability.

These characteristics are retained even when multiple layers of this mesh are compressed to form gaskets or strips. The result is a compressible, resilient, cohesive, conducting material with a large internal surface area. Where hermetic sealing is also required, these gaskets are made in combination with neoprene or similar materials.

Applications

Among the varied applications where Metex "Electronic Weather Stripping" has already proved its effectiveness and economy are: Air craft pulse modulator shields, wave-guide choke-flange gaskets, shielding metal housings, replacing beryllium-copper fingers and springs on TR or ATR tubes, and ignition shielding to prevent radio noise interference.

The facilities of our engineering department are available at any time to assist you in determining the possible adaptability of "Electronic Weather Stripping" to your specific requirements. A letter, addressed to Mr. R. L. Hartwell, Executive Vice President, and outlining briefly your particular problem, will receive immediate attention. No obligation, of course.

METAL TEXTILE CORP.

637 East First Ave., Roselle, N.J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 68A)

Vacuum-Tube Voltmeter

The new type 1803-A vacuum-tube voltmeter, manufactured by **General Radio Co.**, 275 Massachusetts Ave., Cambridge 39, Mass., meets the majority of the ac voltage measurement requirements of the electronics laboratory, and is priced within the budget requirements of the small laboratory.

Voltage range is from 0.1 to 150 volts, covered in 5 steps (1.5-, 5-, 15-, 50-, and 150-volts, full scale). Accuracy is ±3 per cent. Frequency error is 10 per cent at 120 Mc, and correction curves are supplied, by means of which rated accuracy can be obtained up to 200 Mc.

Meter is peak indicating and is calibrated in rms values of sinusoidal voltage. Circuit is designed for high stability, and mechanical assembly is simple and rugged.

Voltage is measured at the terminals of a probe. Where fixed terminals are desired, probe is attached to side of cabinet and wire can be connected to it through an adaptor plug.

Anti-Static Agent for Polystyrene

A new and different anti-static agent for polystyrene plastic, trade-marked D-STAT B, is now available from **Roxbury Chemical Works, Inc.**, 2072 Smith St., Centredale 11, R. I.

The manufacturer claims that D-STAT B is a material which will entirely eliminate unsightly dust collection due to static attraction. It is unique among destaticizers in that it will preserve the brilliance of polystyrene items, such as: radio cabinets, fluorescent lighting fixtures, television lenses, and frames.

Laboratory tests by a leading molding powder manufacturer indicate that polystyrene objects treated with D-STAT B remain static-free even after repeated wipings. D-STAT B is odorless, colorless, and nonflammable, and is applied readily by dipping, spraying, or brushing.

JUST PUBLISHED!

A Complete, Up-to-date Treatment of Waveguide Transmission, Covering Both Mathematical Theory and Practical Applications

HERE at last is a comprehensive, thorough-going study of waveguide techniques that covers not only such practical applications as television and radar, but explores the scientific investigtaion of electromagnetic phenomena, of the sun's spectrum, of the earth's atmosphere, of the absorbtive properties of gases for microwaves, and in measurements of the dialectric properties of insulators and conductors.

PRINCIPLES AND APPLICATIONS OF WAVEGUIDE TRANSMISSION

By GEORGE C. SOUTHWORTH, Ph.D.
Member of the Technical Staff, Bell Telephone Laboratories
Investigator of Waveguide Transmission Phenomena for Approximately Fifteen Years

IN THIS brand-new book, Dr. Southworth has based his study on the remarkable range of source material prepared at the Bell Telephone Laboratories, where much of the evolution of waveguide technique has taken place. Consequently this work reflects the broadest background and the most recent developments in this important, expanding field.

The early chapters of this work provide a broad treatment of the mathematical theory of wageguide transmission. This is immediately followed by a physical interpretation of the phenomena most frequently observed—a two-fold approach that is particularly valuable to students of electrical engineering and applied physics, both in lecture room and laboratory. Professionals chiefly interested in the practical aspects of the subject can proceed directly from the physical interpretation to the remaining chapters, constituting about two-thirds of the book, and dealing with current experimental research and concrete applications.

EXAMINE THIS BOOK FREE

Use the convenient order form below to obtain a copy of this important new work.

PLEASE CUT OUT AND MAIL
Proc. of IRE—850

D. VAN NOSTRAND COMPANY, INC.
250 Fourth Avenue, New York 3, New York

Please send me a copy of PRINCIPLES AND APPLICATIONS OF WAVEGUIDE TRANSMISSION. Within ten days I will either return the book without obligation or send you $9.50.

Name .....

Address .....

City .....Zone ....State .....

don't fail
to see the

AMPEREX TUBE

advertisement
next month
(September issue)
on the inside
front cover

INDEX AND DISPLAY ADVERTISERS

Section Meetings 37A
Student Branch Meetings 40A
Membership 42A
Positions Open 50A
Positions Wanted 52A
News—New Products 30A

DISPLAY ADVERTISERS

Acme Electric Corp. 52A
Aircraft Radio Corp. 45A
Allen-Bradley Co. 20A
American Lava Corp. 17A
Amperex Electronic Corp. 70A
Ampex Electric Corp. 70A
Andrew Corp. 38A
Arnold Engineering Co. 18A

Lester W. Bailey 71A
Bead Chain Mfg. Co. 55A
Bell Aircraft 50A
Bell Telephone Labs. 2A
Berkeley Scientific Co. 55A
Blaw-Knox Co. 26A
Boonton Radio Corp. 64A
Breeze Corp. 37A
W. J. Brown 71A
Bud Radio, Inc. 56A
Burlington Instrument Co. 59A

Cambridge Thermionic Corp. 53A
Cannon Electric Development Co. 68A
Canoga Corp. 60A
Capehart-Farnsworth 50A
Capitol Radio Engineering Inst. 51A
Centralab 33A, 34A, 35A, 36A
C. P. Clare & Co. 27A
Cleveland Container Co. 15A
Sigmund Cohn Corp. 68A
Communication Products Co. 44A
Communications Equipment Co. ..62A & 63A
E. J. Content 71A
Continental Carbon, Inc. 56A
Cornell-Dubilier Electric Corp. ..... Cover III
Cossor Ltd. 65A
Crosby Labs. 71A

Daven Co. 13A
Allen B. DuMont Laboratories, Inc. 70A

Eitel-McCullough, Inc. 6A
Electrical Industries 61A
Electrical Reactance Corp. 7A
Electro-Mechanical Research 59A
Electro-Motive Mfg. Co. 11A
Electro-Search 71A
Erie Resistor Corp. 23A

W. L. Foss 71A

General Electric Co. 5A
General Radio Co. ..... Cover IV

AMPEREX ELECTRONIC CORP.
23 WASHINGTON STREET, BROOKLYN 1, N. Y.
In Canada and Newfoundland: Rogers Majestic Limited
11-19 Brentcliffe Road, Leaside, Toronto, Ontario, Canada
AMPEREX

FOR RECORDING
TELEMETERING SIGNALS
(up to 40 kc.)

Almost overnight Ampex Magnetic Tape Recorders revolutionized radio network broadcasting. Ampex succeeded in this most critical service because of simple and dependable operation, plus a tone quality that is unequalled. Ampex is now available in several models for a wide range of requirements. Inquiries for special instrumentation and industrial control application promptly answered.

- MODEL 300-C $1575
- VU METER PANEL (EXTRA) $105
(F.O.B. San Carlos)

IMPORTANT NEW TOOL FOR INDUSTRY AND SCIENCE
Standard units have dual-speed recording: 7½-15 or 15-30 i.p.s.
AMPEX
MAGNETIC TAPE RECORDER
"STANDARD OF THE GREAT RADIO SHOWS"

Get FREE BOOKLET today!
AMPEX ELECTRIC CORP., San Carlos, California
Without obligation please send 16-page illustrated booklet containing technical specifications of Ampex Magnetic Tape Recorders.

NAME_____
ADDRESS_____
CITY_____ STATE_____
Our need is for:
☐ Laboratory Research ☐ Telemetering
☐ Multi-Channel Recording ☐ Industrial Recording
☐ Recording-Broadcasting ☐ Aerophysical Research

Distributed by . . .
BING CROSBY ENTERPRISES (Hollywood)
AUDIO & VIDEO PRODUCTS CORP. (New York City)
GRAYBAR ELECTRIC COMPANY (Everywhere)
EXPORT: WESTREX (New York City)
AX-5

IT'S
DU MONT
FOR
OSCILLOGRAPHY

Du Mont offers a complete line of cathode-ray oscillographs and associated equipment. For complete information and literature write to

ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
1000 Main Ave., Clifton, N.J.

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES

STABLE • DEPENDABLE • MODERATELY PRICED •
MODEL 28 STANDARD RACK MOUNTING
PANEL SIZE 5¼" x 19" WEIGHT 16 LBS.

- INPUT: 105 to 125 VAC, 50-60 cy
- OUTPUT #1: 200 to 325 Volts DC at 100 ma regulated
- OUTPUT #2: 6.3 Volts AC CT at 3A unregulated
- RIPPLE OUTPUT: Less than 10 millivolts rms

For complete information write for Bulletin G8

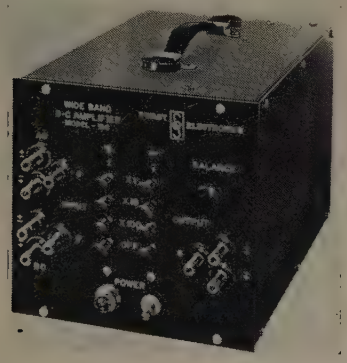
LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

NEWS and NEW PRODUCTS

SEPTEMBER, 1950

Wide-Band DC Amplifier

The Model 120, wide-band dc amplifier was designed by **Furst Electronics,** 12 S. Jefferson St., Chicago 6, Ill., to increase the sensitivity of cathode-ray oscilloscopes with extended low-frequency response. It is also suitable to extend the range of vacuum-tube voltmeters, frequency analyzers, and other instruments, when unusually low frequencies are involved.



The amplifier uses push-pull amplification throughout, and a special cross-coupled circuit is used to achieve stability and low drift. Another advantage of this circuit is the good phase-inversion obtained through its use, so that the amplifier can be used equally well with balanced or unbalanced input signals. If two different signals are applied to the input terminals, the instrument acts as a differential amplifier whereby the difference of these two signals appears push-pull at the output terminals. This makes it possible to observe both the signal to be investigated and a marker or timing signal at the same time. Two independent push-button operated input attenuators permit, in the latter case, mixing of signals of different amplitudes.

The maximum gain is adjusted to approximately 100 and the input attenuators reduce this gain to approximately 10 and 1 (40 db, 30 db, and 0 db, respectively). A fourth position on each attenuator grounds the grid of its input tube, a convenient feature, when, for instance, a single-ended signal is applied to one input terminal only. Grounded terminals are also provided near both dc and ac terminals.

Low Loss Capacitors

A line of vitreous enamel capacitors, 0.68 $\mu\mu$f to 1,000 $\mu\mu$f rated at 500 volts dc, is being marketed by **Vitramon, Inc.,** Stepney, Conn.

Each unit is a laminant of a low loss ceramic dielectric and metallic silver, sintered to produce a monolithic block with stable temperature characteristics. The properties of the materials and the small size insure low losses for all frequencies at temperatures from $-55°$ C to $+200°$ C. The capacitors are finished to meet JAN requirements.

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

New RF Millivolt Meter for VHF

A new type MV-18b high-frequency vacuum-tube millivolt meter to measure frequencies from 1 Mc to 200 Mc flat with direct calibration charts is available from the manufacturer, **Millivac Instruments,** P.O. Box 3027, New Haven, Conn. Its sensitive ranges cover millivolt measurements at frequencies up to 200 Mc and down to a single millivolt.

The instrument contains a new carrier type dc amplifier having exceptionally heavy negative feedback to insure accuracy and stability. Germanium crystal probes are used to rectify weak rf signals with minimum circuit loading. These new probes are designed to have 1.0-$\mu\mu$f input capacity with a tolerance of ± 25 per cent.

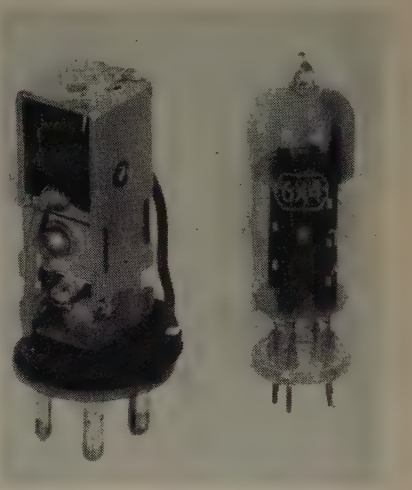
Sharp-Cutoff Miniature Pentode for TV Receivers

The 6CB6, a miniature pentode, for use in television rf tuners and video if amplifiers, with design schematic for a video if amplifier system operating in the 40-Mc region, is available from **Radio Corp. of America, Tube Dept.,** 415 S. Fifth St., Harrison, N. J.

The manufacturer admits that there are various other rf pentodes having lower grid capacitance; however, this is accomplished by shielding the plate, which increases the output capacitance. Because the only capacitance in the tuned circuits of most TV, rf, and if amplifiers is that of the tube electrodes and the wiring, an increase in output capacitance causes a decrease in plate-circuit impedance and a consequent loss in gain. The maximum grid-plate capacitance of the 6CB6 is 0.020 $\mu\mu$f; its output capacitance is 1.9 $\mu\mu$f.

New Vibrator

A new vibrator for dc conversion is hereby announced by **Harold J. Brown,** Mattapoisett, Mass., specifically designed for severe and exacting requirements; and embodying new concepts of design.



This vibrator will be available in both standard and high frequency forms, and for low and high power applications. It is generally smaller and more easily applied than is usual, while at the same time it is rugged and shock resistant. When combined with proper circuitry, either long life or high power may be obtained. A minimum of excitation power is needed for use in very low power applications such as in zero output devices.

Electronic Television Mixer

A new electronic television mixer, Type TV-19-A, for automatic and manual fading, lapping, and dissolving of television pictures, has been announced by the **Commercial Equipment Div., General Electric Co.,** Electronics Park, Syracuse, N. Y.

When combined with GE control panels TC-21-A or TC-31-A, the mixer will provide split-second timing between channels and, because the operation of the system is largely automatic, switching errors are reduced. It is built for both portable and studio use.

The new electronic mixer will take up to four noncomposite inputs from camera channels and will fade or switch between any two of the four. The output of the video mixer is fed to a sync mixer and then to the output stage. The output is composite and ready for transmission use. Any one of the four mixer inputs can be bypassed around the video mixer to the sync mixer and output circuits; and thus leave the remainder of the mixer free for rehearsals which can be viewed by the noncomposite monitor output. Manual operation is also provided for special effects, such as superpositions.

(Continued on page 40A)

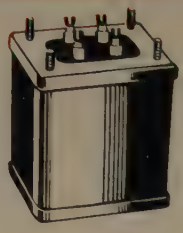
FREED

TRANSFORMERS & INSTRUMENTS

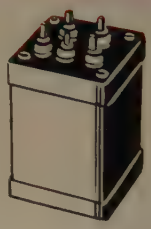
"PRODUCTS OF EXTENSIVE RESEARC

NO. 1060 VACUUM TUBE VOLTMETER INPUT IMPEDANCE 50 MEGOHMS

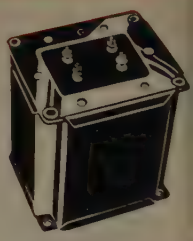
NO. 1030 LOW FREQUENCY "Q" INDICATOR



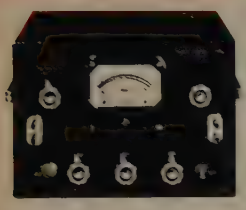
HIGH FIDELITY TRANSFORMERS ½ DB 20 CPS TO 30 KC



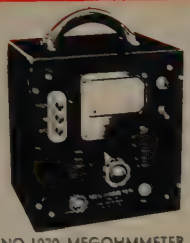
DISCRIMINATORS 10 CPS TO 1 MC



COMMERCIAL COMPONENTS QUALITY — DEPENDABILITY — PRICE



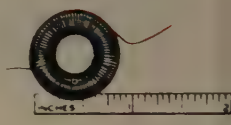
NO. 1140 NULL DETECTOR COMPLETE WITH SELECTIVE CIRCUITS



NO. 1020 MEGOHMMETER 2,000,000 MEGOHMS DIRECT READING

HERMETICALLY SEALED COMPONENTS TO MEET MIL-T-27 SPECS.

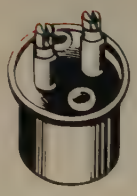
TOROIDAL INDUCTORS 60 CPS TO 1 MC



MINIATURE INDUCTORS 1000 CPS TO 100 KC

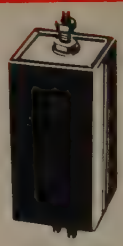
NO. 1210 NULL DETECTOR & VACUUM TUBE VOLTMETER

DECADE INDUCTORS 30 CPS TO 300 KC

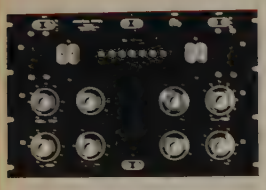


SUB MINIATURE HERMETICALLY SEALED TOROIDAL INDUCTORS

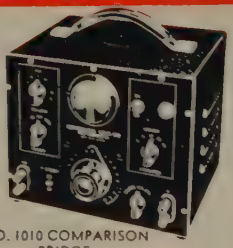
SUB MINIATURE HERMETICALLY SEALED COMMUNICATION COMPONENTS



SLUG TUNED COMPONENTS 1000 CPS TO 1 MC

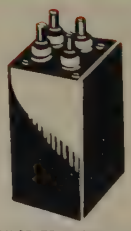


NO. 1150 UNIVERSAL BRIDGE 5 A.C. BRIDGES IN ONE UNIT

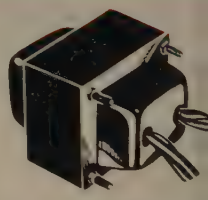


NO. 1010 COMPARISON BRIDGE FAST, ACCURATE, RELIABLE

STEPDOWN TRANSFORMERS 50 WATTS TO 3 KW



PULSE TRANSFORMERS FROM WATTS TO MEGAWATTS

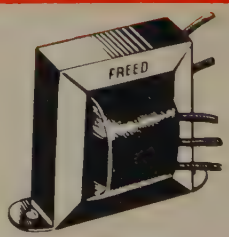


POWER TRANSFORMERS RUGGED, DEPENDABLE, INEXPENSIVE.

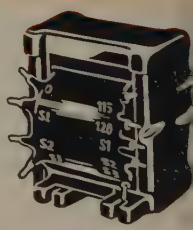
1170 D.C. SUPPLY DIRECT CURRENT UP TO 500 MA.

NO. 1110 INCREMENTAL INDUCTANCE BRIDGE A NECESSITY FOR EVERY LAB.

PRECISION FILTERS 10 CPS. TO 1 MC.



CHANNEL MOUNTING INEXPENSIVE—RELIABLE



FOSTERITE TREATMENT ANE-19 SPECS.

SEND FOR LATEST CATALOG!

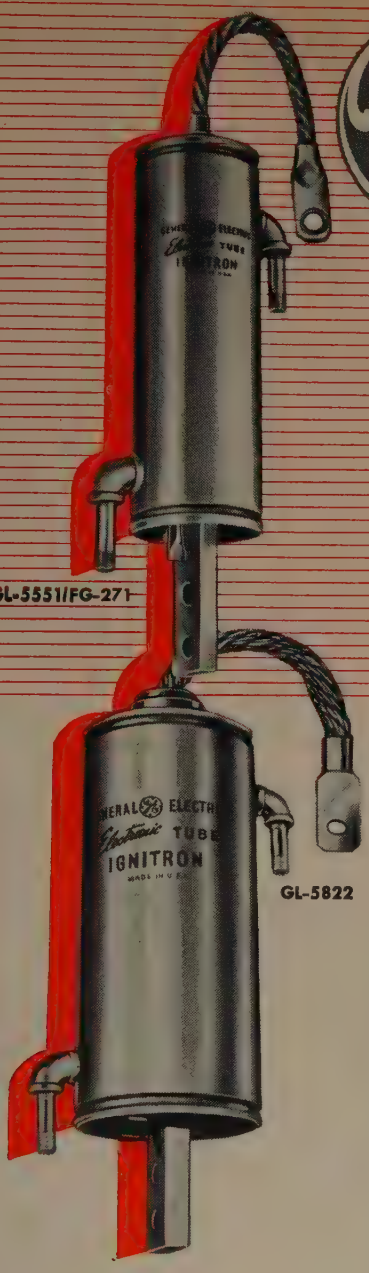
FREED TRANSFORMER CO., INC.

DEPT. SP 1718-36 WEIRFIELD ST., (RIDGEWOOD) BROOKLYN 27, NEW YORK

MEMO TO WELDER MANUFACTURERS

FOR PLUS VALUES

Specify G-E Ignitrons



—More tube-design know-how! General Electric pioneered electronic controls for welding.

—More precise G-E manufacture, using highest-grade materials.

—More step-by-step tube inspections—more top-rating final tests before the product reaches your hands.

EXPERIENCE is the best guide to dependable tube design. Because electronic welding control is a G-E "first," General Electric experience excels. Twenty years ago—to name but one example of leadership—the first electronic welder used in the automotive industry was built by General Electric. Thousands of similar welders speed car and truck production today.

Backed by this big fund of practical welding knowledge, G-E control ignitrons should lead in quality. And they do!

A check of component materials, shows instance after instance of choice based solely on quality. Precision manufacture shapes these selected materials into sturdy, long-serving G-E ignitrons which—having passed a series of rigid inspections—then are subject to extensive tests under actual welder conditions at max ratings.

G-E ignitrons are *right* when you install them, and they stay right! Let expert G-E tube engineers work with you on their application. Wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

GL-5551/FG-271

One of the most widely used G-E ignitrons—an established favorite in the welding industry. With max kva demand 600, the average anode current is 30.2 amp. Max average anode current of 56 amp checks with a kva demand of 200.... Other popular G-E ignitrons for resistance welding are the GL-5550/GL-415, GL-5552/FG-235-A, and GL-5553/FG-258-A. Ratings sent promptly on request.

GL-5822

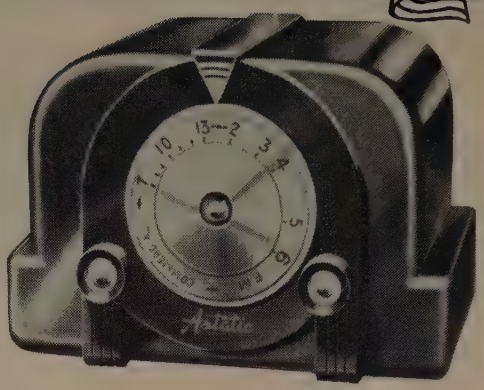
Newest of the G-E ignitron line, and expressly designed for the rapidly growing 3-phase welding field. Peak voltage forward and inverse is 1,200 v, with peak and avg anode currents of 1,500 and 20 amp, or 420 and 70 amp . . . or 1,500 v, with currents of 1,200 and 16 amp, or 336 and 56 amp. Straight-line interpolation on log-log paper is allowed between similar current points. . . . Other G-E ignitrons for 3-phase welding are the GL-5554/FG-259-B and GL-5555/FG-238-B. Ratings gladly furnished.

GENERAL ELECTRIC

180-J28

Presenting the NEW Astatic TV and FM Boosters Models BT-1 and BT-2

Astatic raised tremendously the level of improved TV reception through pre-amplification of signal, when it developed its famous de-luxe model AT-1 Booster with exclusive variable gain control and dual tuning. Now Astatic brings another great advancement to the progress of TV enjoyment — with two low-cost boosters that equal, to all practical purposes, the primary function of the highest priced units. Never before has so much quality been incorporated in a booster to sell at so low a price. Why not get the complete details? Write today.



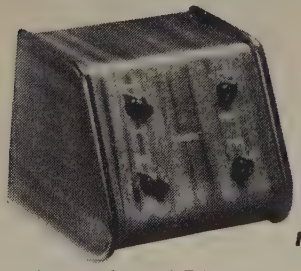
Booster Model BT-2
List Price $32.50

Booster Model BT-1
List Price $29.95

LOOK AT THE AMAZING QUALITY FEATURES IN THESE LOW-PRICED BOOSTERS

1. Employ Mallory Inductuner for continuous variable tuning.
2. High gain, very uniform on both high and low channels.
3. Simplified controls—single tuning knob with continuous tuning through both TV and FM bands.
4. Band width adequate over entire range.
5. Low noise design and construction.
6. No shock hazard to user.
7. Off-on switch for easily cutting in and out of circuit.
8. Selenium rectifier.
9. Use single 6AK5 Tube.
10. Provide for either 72 ohm or 300 ohm impedance input and output.
11. Model BT-2 has handsome, dark brown plastic cabinet.
12. Model BT-1 has metal cabinet in rich mahogany woodgrain finish.
13. Large dial face is easy to see in tuning.
14. Model BT-2 has recessed pilot light to show when booster is on.

Only ASTATIC offers as complete a choice of BOOSTER MODELS



Booster Model AT-1
List Price $49.50

Increasing numbers of TV set owners will still want the finest Booster that money can buy — and that means Astatic's deluxe Models AT-1 and AT-1B, with rich furniture finish mahogany or blond wood cabinet, exclusive and variable gain control, dual tuning and powerful four-tube operation.

THE Astatic CORPORATION
ASTATIC
CONNEAUT, OHIO
IN CANADA CANADIAN ASTATIC LTD TORONTO ONTARIO

SECTION MEETINGS

Baltimore

"The Omegatron and Measurement of Atomic Constants," by J. A. Hipple, National Bureau of Standards; May 10, 1950.

"An Experimental Harbor Radar Installation," by R. H. Foy, Westinghouse Electric Corporation; Election of Officers; June 14, 1950.

Beaumont-Port Arthur

Business Meeting; June 16, 1950.

Buenos Aires

"Information Coding," by P. J. Noizeux; Business Meeting; April 21, 1950.

"The Industrialized Television," by J. P. Calvelo; Business Meeting, May 19, 1950.

"Teleprinting on Radio," by H. C. A. van Duuren; June 2, 1950.

Cincinnati

Student Paper Competition; June 1, 1950.

"Education and Training in Industry," by E. D. McConnell, Gruen Watch Company; Election of Officers; June 20, 1950.

Connecticut Valley

Family Outing; June 10, 1950.

Dallas-Fort Worth

"Radio Communication in the Petroleum Industry," by Jerry Stover, Communication Engineering Company; June 20, 1950.

Emporium

"Analog Computers," by H. R. Hegbar, Goodyear Aircraft Corporation; June 20, 1950.

Evansville-Owensboro

"Television Receiver Circuits," by Bernard Parmet, Motorola, Inc.; June 21, 1950.

Hawaiian

"Symposium on Modern Electronic Test Equipment," by R. S. Willard, Mutual Telephone Company, Mr. Bostwick and Mr. Chittenden, CAA, Hnl., and C. R. Gilmartin, Hawaiian Airlines; June 27, 1950.

"Power and Audio Transformer Design Considerations," by Fred Mason, Pearl Harbor Shipyard; July 12, 1950.

Milwaukee

Business Meeting; April 6, 1950.

"Recent Progress in Ferromagnetism," by Charles Kittel, Bell Telphone Laboratories; April 19, 1950.

"A New Approach to Loudspeaker Design," by Howard Southers, Electro-Voice, Inc; June 23, 1950.

Salt Lake

"Acoustic Qualities Necessary for Music Enhancement and Understandability in Speech," by C. R. Evans, Radio Station KSL; June 1, 1950.

San Diego

"Basic Principles of Digital Computers," by R. G. Nye, U. S. Navy Electronics Laboratory; June 6, 1950.

"Shipborne Radar Design Considerations," by I. L. McNally, U. S. Navy Electronics Laboratory; July 11, 1950.

San Francisco

"Color Television," by George Sleeper, Color Television, Inc; May 22, 1950.

"Modern Methods in Electrical Communication," by Ralph Bown, Bell Telephone Laboratories; May 25, 1950.

(Continued on page 35A)

(Continued from page 34A)

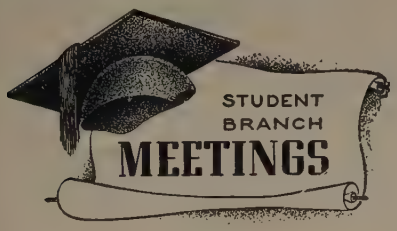
"Electrical Measurement of Microsecond Duration Dynamic Strains," by Lester Roberts, Graduate Student, Stanford University, "The Electro-Optical Shutter," by Timothy Murphy, Student, Santa Clara University, and "An Ultra-Low Frequency Sine Wave Oscillator," by Kenneth Kiser, Graduate Student, University of California; June 7, 1950.

SEATTLE

"An Analysis of Several Propagation Surveys in the VHF Region for Industrial Communication," by W. J. Reed, Boeing Airplane Company; June 15, 1950.

WASHINGTON

"Atomic Time and Frequency Standards," by Harold Lyons, CRPL/NBS; June 12, 1950.



ALABAMA POLYTECHNIC INSTITUTE, IRE BRANCH

Business Meeting; June 26, 1950.

Film: "Frequency Modulation"; Business Meeting; July 10, 1950.

UNIVERSITY OF DAYTON, IRE BRANCH

"Number Systems," by Roy Hearsum, National Cash Register Company; May 2, 1950.

"Electronic Civil Service Employment," by Ken Bornhorst, Albert Chong, and James Dapper, Students, University of Dayton; May 9, 1950.

"Electronic Civil Service Employment," by Ken Bornhorst, Albert Chong, and James Dapper, Students, University of Dayton; May 16, 1950.

Election of Officers; May 23, 1950.

FENN COLLEGE, IRE BRANCH

"Navigational Aids on the Great Lakes," by Zenn Zenon, Student, Fenn College; June 30, 1950.

MARQUETTE UNIVERSITY, IRE-AIEE BRANCH

Business Meeting; Election of Officers; June 29 1950.

MISSISSIPPI STATE COLLEGE, IRE BRANCH

Business Meeting; Election of Officers; May 18, 1950.

SAN JOSE STATE COLLEGE, IRE BRANCH

Election of Officers; June 16, 1950.

STANFORD UNIVERSITY, IRE-AIEE BRANCH

Field Trip through Westinghouse Company; May 5, 1950.

Student Paper Contest; May 12, 1950.

Field Trip through Newark Power Sub-Station; May 19, 1950.

"A Review of Stanford Electronics Laboratory," by Karl Spangenberg, Faculty, Stanford University; Election of Officers; May 31, 1950.

UNIVERSITY OF TEXAS, IRE-AIEE BRANCH

Technical Paper Contest; Film: "Television and How it Works"; February 6, 1950.

"Principles and Use of the Transistor," by Dr. Watson, Faculty, University of Texas; February 27, 1950.

"Servomechanism," by A. R. Teasdale, Jr., Faculty, University of Texas; March 6, 1950.

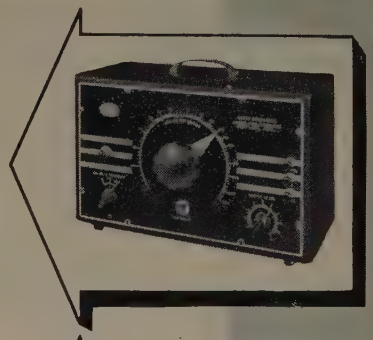
"Computer," by Cyril Hoyler, Radio Corporation of America; March 23, 1950.

CHECK "Proof of Performance" with these PROVED B&W PERFORMERS

For those "proof-of-performance" tests required by the FCC, here's a combination that will enable you to comply with the least amount of time . . . trouble . . . and money!

AUDIO OSCILLATOR
MODEL 200 . . . . . $115

Provides a low distortion source of audio frequencies between 30 and 30,000 cycles. Self-contained power supply. Calibration accuracy ±3% of scale reading. Stability 1% or better. Frequency output flat within 1 db, 30 to 15,000 cycles.



DISTORTION METER
MODEL 400 . . . . . $140

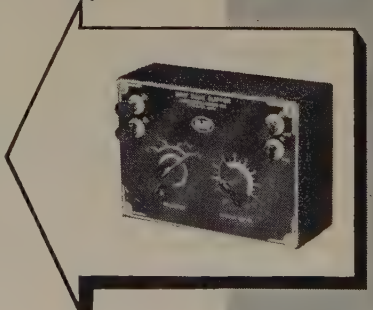
For fundamentals from 30 to 15,000 cycles measuring harmonics to 45,000 cycles; as a volt and db meter from 30 to 45,000 cycles. Min. input for noise and distortion measurements .3 volts. Calibration: distortion measurements ±5 db, voltage measurements ±5% of full scale at 1000 cycles.

LINEAR DETECTOR
MODEL 404 . . . . . $85

Provides combined RF detector and bridging transformer unit for use with any distortion meter. RF operating range: 400 kc to 30 mc. Single ended input impedance: 10,000 ohms. Bridging impedance 6000 ohms with 1 db insertion loss. Frequency is flat from 20 to 50,000 cycles.

SINE WAVE CLIPPER
MODEL 250 . . . . . $10

Speeds accurate analysis of audio circuits by providing a test signal for examining transient and frequency response . . . at a fraction of the cost of a square wave generator. Designed to be driven by an audio oscillator.



SEE YOUR DEALER OR WRITE TODAY FOR COVERING LITERATURE, DEPT. PR-90

BARKER & WILLIAMSON, Inc.

237 Fairfield Avenue **Upper Darby, Penna.**

Exactly As Specified

JOHNSON

ANTENNA PHASING EQUIPMENT

Typical phasing unit in JOHNSON cabinet. We can match in design and finish any make of transmitter cabinet.

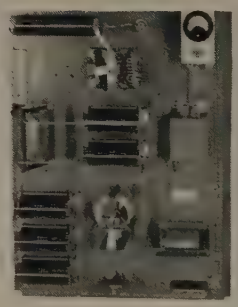
is an outstanding characteristic of Careful attention to specifications JOHNSON Antenna Phasing Equipment. It is made possible principally because each installation is individually designed. There are no "standard units" which must be adapted, no need of compromises with good engineering. You get what your consultant specifies!

Does this cost a lot? Emphatically no! Because JOHNSON manufactures nearly every component in an adequate variety of ratings and types, our engineers have available just the right material for any application. The cost is no more—frequently it is lower than less flexible, less generously rated equipment.

The same appreciation of technical and economic requirements is evident in other related JOHNSON equipment such as: coaxial line, phase sampling loops, isolation filters, tower lighting filters, RF contractors, pressurized capacitors, variable inductors and open wire line supports.

For detailed information on any of these products write:

Weatherproof antenna coupling unit. Features an interior door which remains closed during adjustments.



Panel mounted coupling network saves money where a tuning house is used. Every major component but the meter is JOHNSON built.

JOHNSON . . . *a famous name in Radio!*

E. F. JOHNSON CO., WASECA, MINNESOTA

The following transfers and admissions were approved and will be effective as of September 1, 1950:

Transfer to Senior Member

Babillus, J., 1381 Elmhurst Dr., N.E., Cedar Rapids, Iowa
Bowler, G. E., 7951 Stewart Ave., Los Angeles 45, Calif.
Farmer, E. W., 174 Montee Sanche, Ste. Therese de Blainville, Que., Canada
Fox, J., 7 Spring Terr., Red Bank, N. J.
Gruenberg, E. L., 20 Bethune St., New York 14, N. Y.
Hollenberg, A. V., Bell Telephone Laboratories, Inc., Murray Hill, N. J.
Jones, C. H., 3857 Greensburg Pike, Pittsburgh 21, Pa.
Jones, W. J., 319 Covent Ave., New York 31, N. Y.
Kibler, P. J., 8937 Yorktown Ave., Los Angeles 45, Calif.
Ley, G. S., 110 Mt. Lebanon Blvd., Pittsburgh 16, Pa.
Lyon, J. A. M., Department of Electrical Engineering, Northwestern University, Evanston, Il.
Nelson, A. B., 618 Burlington Ave., Bristol, Conn.
Norlund, Rl J., 214 E. Second St., Xenia, Ohio
Raburn, L. E., 1012 St. James Blvd., Evansville, Ind.
Sather, O. J., 755 Hartwell St., Teaneck, N. J.
Schneeberger, R. J., Westinghouse Research Laboratories, E. Pittsburgh, Pa.
Scott, G. H., Engineering Hall, University of Arkansas, Fayetteville, Ark.
Sherman, J. B., Electrical Engineering Department, The Cooper Union, Cooper Sq., New York 3, N. Y.
Spencer, R. C., 247 Park Ave., Arlington 74, Mass.
Story, T. H., 2831 Cove Rd., Merchantville 8, N. J.
Sullivan, A. H., Jr., 2812 Hillside Ave., Dayton 9, Ohio
Westneat, A. S., Jr., R.F.D. 1, Box 287, Princeton, N. J.
Wolf, L. J., 210 New Jersey Ave., Collingswood 7, N. J.

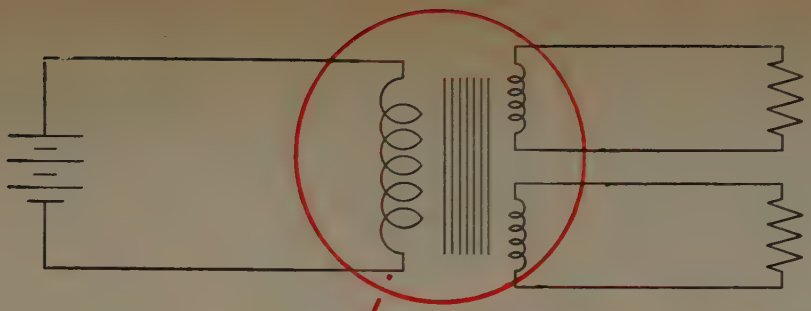
Admission to Senior Member

Mapes, C. M., 195 Broadway, New York 7, N. Y.
Molloy, C. T., Bell Telephone Laboratories, Inc., Murray Hill, N. J.
Petersen, R. P., 3013-31 Pl., Sandia Base Branch, Albuquerque, N. Mex.
Rantzen, H. B., Rm. CA-025A, United Nations, Lake Success, N. Y.
Rumsey, V. H., 2214 Jervis Rd., Columbus 12, Ohio
Weiss, R. A., Box 25, Ocean St., Highlands, N. J.

Transfer to Member

Benner, A. H., Box 618, State College, Pa.
Burnett, K. H., 42 Oakland St., W. Springfield, Mass.
Busse, C. C., 8 Warriors Rd., Pittsburgh 5, Pa.
Chatterjee, A. K., Birla Engineering College, Pilani, Jaipur State, India
Coburn, E. D., Box 1527, Beaumont, Tex.
Das, J., Technical Maintenance Officer, West Command Signal Regt., New Delhi, India
Ellison, G. C., Jr., 11310 S.E. Market St., Portland 16, Ore.
Graustein, W. W., Jr , 20 Edward Rd., Watertown, Mass.
Hopkins, R. U. F., 4003 Atascadero Dr., San Diego 7, Calif.
Hummer, J. L., Electrical Engineering Department, Rhode Island State College, Kingston, R. I.

(Continued on page 38A)



a DC transformer?

Certainly...

Bendix Specialized Dynamotors are made for the Job!

Whenever DC power is required at other than the supply voltage, Bendix* Specialized Dynamotors function as DC transformers. They can be wound for any input or output voltage between 5 and 1200 volts, and they can deliver power up to 500 watts. Multiple outputs can be supplied to correspond with several secondaries on transformers, and their output voltages can be regulated within close limits regardless of input voltage or load variations. Bendix Specialized Dynamotors are tailored to the exact requirements of each application by the design of the windings used in standardized frames. This reduces the cost, size and weight to an absolute minimum, consistent with the operational requirements. Compliance with Government specifications is assured by the choice and treatment of materials and the basic design. *A complete description of your requirements will enable our engineers to make concrete recommendations . . . All orders are filled promptly and at moderate cost.*

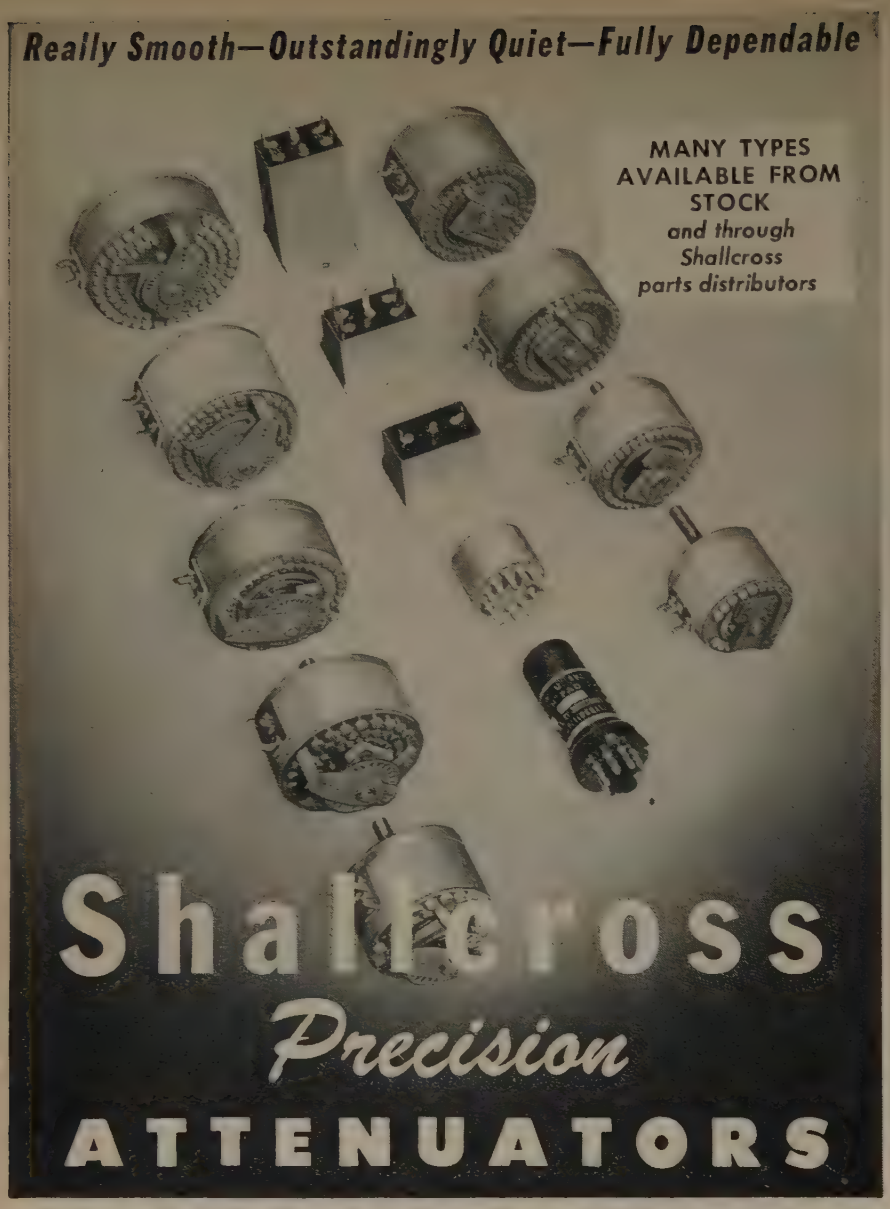
*REG. U. S. PAT OFF.

RED BANK DIVISION OF
BENDIX AVIATION CORPORATION
RED BANK, NEW JERSEY
Export Sales: Bendix International Division, 72 Fifth Avenue, N. Y. 11, N. Y.

Write for this colorful and informative book —it's free. You'll find it loaded with facts and figures about all types of dynamotors.

RED BANK DIVISION

Bendix
AVIATION CORPORATION



ALL STANDARD FIXED AND VARIABLE TYPES
•
LADDER AND BALANCED LADDER CONTROLS
•
"T" CONTROLS
•
BALANCED "H" CONTROLS
•
POTENTIOMETERS
•
VARIABLE IMPEDANCE MATCHING NETWORKS
•
V.U. METER RANGE EXTENDING ATTENUATORS
•
STANDARD AND SPECIAL FIXED PADS
•
SPECIAL NETWORKS

Perhaps you've noticed how frequently Shallcross attenuators now appear in the finest audio or communications equipment? Or how often they are chosen for replacement purposes?

There's a reason! Improved design, materials and production techniques have resulted in a line that sets new, higher standards of attenuation performance for practically every audio and communications use.

Shallcross Attenuation Engineering Bulletin 4 gladly sent on request.

Shallcross Manufacturing Co.
Dept. PR-90 Collingdale, Pa.

RESISTORS — INSTRUMENTS — SWITCHES — ATTENUATORS

(Continued from page 36A)

Jones, R. W., Box 283, Naval Base, S. C.
Klopfenstein, R. W., 27 E. 10 Ave., Runnemede, N. J.
Lee, H. E., 2031 Thomas Ave., San Diego 9, Calif.
Pace, R. A., Civil Aeronautics Administration, Annette, Alaska
Ray, H. A., Jr., 1052 Warner Bldg., Washington, D. C.
Stokes, B. C., 29 Vanderbilt Ave., Floral Park, N. Y.
Triman, E. L., 5349 N. Oriole Ave., Chicago 51, Ill.
Valach, C. F., 2502 Elmwood Ave., Berwyn, Ill.
Webb, E. E., 718 E. Melton St., Longview, Tex.

Admission to Member

Brown, J. S., West Ealing, 16 Douglas Gardens, London, England
Chrisman, D. W., 515 S. Wellesley Ave., Albuquerque, N. Mex.
Gage, G. H., Jr., 1332 Claranette Ct., Owensboro, Ky.
Kirkby, R. L., RCAF Station, Clinton, Ont., Canada
Knowlton, K. R., 844 Kingston Rd., Toronto 8, Ont., Canada
Lord, W. P., 60 Neptune St., San Antonio, Tex.
Lovell, R. E., c/o La Villite, Alamogordo, N. Mex.
Martin, E. J., Physics Laboratories, Sylvania Electric Products Inc., Box 6, Bayside, L. I., N. Y.
Noe, J. B., 3125-40 St., Sandia Base, Albuquerque, N. Mex.
Parke, N. G., III, Independence Ct., Concord, Mass.
Peck, D. G., c/o Telecommunication Department, Kuantan, Pahang, Malaya
Pfund, E. T., Jr., 190 Oakland Ave., Methuen, Mass.
Prescott, R. S., 6 Forest St., Lexington 73, Mass.
Robinson, H. E., 867 N. Abingdon St., Arlington, Va.
Saunders, M. E., 1041 W. 53 Ave., Vancouver, B. C., Canada
Sodhi, S. S., 15, Bachumal Bldgs., Chunamandi, Paharganj, New Delhi, India
Surdam, E. L., 1002 Terminal Sales Bldg., Portland 5, Ore.
Torn, L. J., Airborne Instruments Laboratory, Inc. 160 Old Country Rd., Mineola, L. I., N. Y.
Townley, R. C., 155 Gold St., N. Arlington, N. J.
Tripp, A. L., 9 Chico Ct., S. San Francisco, Calif.
Valder, F. L., 43 Hopton Rd., Streatham, London S.W. 16, England
Weed, A. C., Jr., 5311 Dorchester Ave., Chicago 15, Ill.
Wilcox, R. B., 78 Waban Park, Newton 58, Mass.

The following elections to Associate grade were approved and will be effective as of August 1, 1950:

Abell, V. F., Solomons, Md.
Agrawal, C., All India Radio, Queens Rd., Bombay, India
Alegria, M. G. S., C.P. 1229-CFL, Luanda, Angola, Portuguese West Africa
Barnett, K. G., 348 Hawthorne St., Glendale 4, Calif.
Boden, E. H., General Delivery, Emporium, Pa.
Bonnett, J. D. W., 815 W. 25 Ave., Vancouver, B. C., Canada
Bosted, N. P., 1022 N. Negley Ave., Pittsburgh, Pa.
Boulder, A. G., 4449-14 St., Canton, Ohio
Canto, L., Barnard Hall, North Brothers Island, New York, N. Y.
Caro, D. E., Physics Department, The University, Edgbaston, Birmingham 15, England
Chun, H. W. M., 1246 Matluck Ave., Honolulu 24, T. H.
Crossland, O. C., 246 Hable St., Denver-Harbor, Houston, Tex.

(Continued on page 39A)

(Continued from page 38A)

Culbertson, H. B., 2307 Village Way, Dallas, Tex.
Ellis, G. A., 5931 Thekla St., St. Louis 20, Mo.
Emerson, W. P., 50 School St., Lexington 73, Mass.
Fitzgerald, M. W., 1019 W. 19 St., N. Vancouver, B. C., Canada
Foster, C. P., Jr., 609 MacArthur, Redwood City, Calif.
George, H. A., Box 384, Bayville, L. I., N. Y.
Gerdes, C. V., Monsanto Chemical Company, 1515 Nicholas Rd., Dayton 7, Ohio
Hatchl, S., 1112 Jackson Blvd., Houston 6, Tex.
Hawk, J. M., 3009 Wood St., Ames, Iowa
Heising, C. R., Bldg. 63, General Electric Company, Lynn, Mass.
Hembise, P. M., Sneach Pond Rd., Manville, R. I.
Hepburn, J. T., 1149 Cortell Rd., N. Vancouver, B. C., Canada
Hilton, B. C., Canadian Broadcasting Corporation, 701 Hornby St., Vancouver, B. C., Canada
Holmes, G. A., 754 Carroll St., Akron 5, Ohio
Holmgren, J. D., 385 S. Greenwood Ave., Pasadena 10, Calif.
Horan, W. H., 10 Brooks St., S. Natick, Mass.
Itenson, V. A., 1050 LeRoi St., Vancouver, B. C., Canada
Jones, D. T., 3576 Anzio Dr., Vancouver, B. C., Canada
Kent, N. S., 1607 W. 58 St., Vancouver, B. C. Canada
Lee, F. G., 2549½ S. Spaulding Ave., Los Angeles 16, Calif.
Lisiecki, M., 1252 Greystone Rd., Baltimore 27, Md.
Marini, J. W., 2603 Southern Ave.. S.E., Washington, 20, D. C.
Martin, H. R., 1621 S. Bloomington, Streator, Ill.
Mayeda, T. A., 4800 Georgia Ave., N.W., Washington 11, D. C.
Neveroski, F., 202 N. Howard Ave., Vancouver, B. C., Canada
Oliver, W., 1 Moorlands Grove, Morecamre, Lancs., England
Oltman, H. G., Jr., 636 Fairway Dr., Albuquerque, N. Mex.
Oshokoya, S. O., 68 Kadara St., Ebute-Metta, Nigeria, West Africa
Peterson, R. W., 3919 Dalton Ave., Los Angeles 37, Calif.
Pierce, J. R., 1075 N. Eighth, Las Cruces, N. Mex.
Pye, R. M., 3671 Point Grey Rd., Vancouver, B. C., Canada
Quackenbush, E. C., 664 Downer Pl., Aurora, Ill.
Rayment, C. V., 52 Cooper St., Ottawa, Ont., Canada
Riddell, A. I., 360 E. 16 St., N. Vancouver, B. C., Canada
Rosenstein, G. M., 338 Wellesley Rd., Philadelphia 19, Pa.
Russo, L. J., Jr., 178 Grove St., N. Plainfield, N. J.
Schneiderman, M., 45 Martin Ave., Clifton, N. J.
Souch, W. F., Canadian Marconi Company, 149 Portage Ave., E., Winnipeg Man., Canada
Sullivan, H. B., 2419 Hulseman Ter., Philadelphia, Pa.
Teasdale, A. R., Jr., Electrical Engineering Department, University of Texas, Austin, Tex.
Tripp, H. H., 825 W. Eighth Ave., Vancouver, B. C., Canada
Turchan, P. J., 1714 S. Desplaines St., Chicago 16, Ill.
Walsh, J. D., USAFIT, MCLI, Box 3336, Wright-Patterson AFB, Dayton, Ohio
Warren, D. S., 750 Hillside Ave., Plainfield, N. J.
Weeks, J. P., 1139 National Ave., Memphis, Tenn.
Wilson, C. M., 514 W. Keith Rd., N. Vancouver, B. C., Canada
Woodson, M. P., 601 19 St., N.W., Washington 6, D. C.

BULLETIN 5008

Just off the press!

Flexible shafts—the very latest information and engineering data on power drive and remote control flexible shafts and casings, brought up to date to include latest developments.

It also tells you how to select shafts and casings for specific applications and how to work out the necessary details.

Write for a free copy today.

THE S. S. White DENTAL MFG. CO. INDUSTRIAL DIVISION

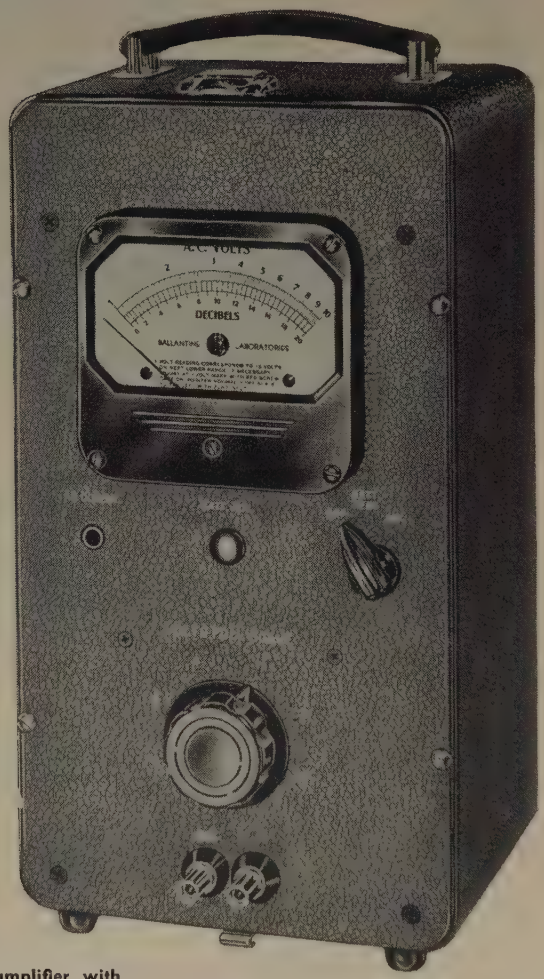
Dept. G, 10 East 40th St.
NEW YORK 16, N. Y.

Announcing...

IMPROVEMENTS IN THE

BALLANTINE BATTERY OPERATED ELECTRONIC VOLTMETER

Achieving a tenfold increase in sensitivity, higher input impedance, improved low frequency response and substantial reduction in size and weight.



VOLTAGE RANGE:
100 microvolts to 100 volts in 6 decade ranges.

INPUT IMPEDANCE:
2.2 megohms shunted by 8 mmfd on high ranges and 15 mmfd on low ranges.

FREQUENCY RANGE:
2 cycles to 150,000 cycles.

ACCURACY:
3%, except 5% below 10 cycles and above 100,000 cycles.

- Available multipliers, amplifiers and shunts extend further the range and usefulness.
- Can also be used as a pre-amplifier with maximum gain of 60 DB.
- Features the well-known Ballantine logarithmic voltage and uniform DB scales.
- Battery life over 150 hours.

MODEL 302B
Size: 6⅞" x 7½" x 12⅜".
Weight: 17 lbs.
Price complete with cover and batteries: $215.

For further information on the Ballantine Model 302B and other Ballantine Sensitive Electronic Voltmeters and accessories measuring up to 5.5 megacycles, write for catalogue.

BALLANTINE LABORATORIES, INC.

102 FANNY ROAD, BOONTON, NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 30A)

Null Detector and VTVM

The **Freed Transformer Co.**, 1718-36 Weirfield St., Brooklyn (Ridgewood) 27, N. Y., is now delivering their new null detector and vacuum-tube voltmeter, No. 1210.

This unit has been designed for ac bridge measurements. It provides simultaneous measurement of the voltage across the unknown and the balance of the bridge. This vacuum-tube voltmeter has a sensitivity of 0.1, 1, 10, and 100 volts. The input impedance is 50 megohms shunted by 20 $\mu\mu$f. The frequency range is from 20 cps to 20,000 cps. Null detector—gain 94 db. It has selective circuits for 60–400–1,000 cps and a frequency range of 20 to 30,000 cps.

New Audio Amplifiers

The **Altec Lansing Corp.**, 1161 N. Vine Street, Hollywood 38, Calif., has announced a new series of amplifiers designed specifically for use with the Altec miniature condenser microphone. By newly developed circuits, these amplifiers eliminate the need for several elements now necessary in microphone amplifier systems. With this new circuit, power for the condenser microphone impedance matching tube is obtained from the amplifier rectifiers. No input transformers or input matching transformers are required.

First of the new series is the A-332A amplifier, an 18-watt portable public address unit. Three inputs are provided, two for the miniature condenser microphone, and one for variable reluctance phonograph pickup. Each of the three channels is provided with independent gain and bass controls. A high-frequency droop control is provided for all input channels. When more than 18 watts of power is required, the A-332A may be used to drive the 75-watt A-247B Amplifier.

(Continued on page 42A)

Pan American pioneers radiotelephone network

. . . equipment by COLLINS

When Pan American World Airways opened a route into the Middle East in 1947, all en route plane-ground communications had to be performed by radiotelegraph—the dot-dash system. A radiotelephone network, like that used on the United States airways, did not exist overseas.

Today, through the initiative of Pan American, messages can be exchanged immediately by radiotelephone between Clipper pilots and ground radio-operators over every foot of the Clipper routes from New York to Basra, Iraq, and from New Delhi, India, eastward round the world to San Francisco.

To accomplish this extensive pioneering job, Pan American has invested three years of work and a large sum of money. This airline has negotiated permission for radio stations with foreign governments, and has installed these stations at a number of points in Europe and Asia. Pilots and ground personnel have been trained for the new operation, and the Clippers' radio installations have been modified from radiotelegraph to radiotelephone.

The major radio units chosen by Pan American World Airways for this purpose, and for the Caribbean area, are Collins high frequency ground station and airborne transmitters and receivers. Included are Collins 231D 3.5/5 kilowatt Autotune* transmitters, 16F 300/500 watt Autotune* transmitters and 51N receivers on the ground, and 18S transmitter-receivers in the air.

To complete the modernization of its ROUND THE WORLD system, Pan American has installed Collins 231D and 16F transmitters, and 51N receivers, in route stations at Santa Maria, Lisbon, London, Munich, Vienna, New Delhi, Calcutta, Bangkok, Manila, Honolulu, Los Angeles, San Francisco and Seattle; a 16F transmitter and 51N receivers at Vienna; a 16F transmitter at Damascus; and 51N receivers at Rome.

Additionally, a great improvement in ground radiotelephone service was made at Munich. There, VHF communications were relocated from the airport to the top of 10,000-foot Mount Zugspitze in the Bavarian Alps, whence a Collins 3000A very high frequency transmitting and receiving installation increases the effective operating radius from 50 to 250 miles, covering an area from Luxemburg to Milan, Italy.

This pioneering by Pan American World Airways is in the best tradition of American free enterprise. Collins is proud to have been chosen to play a part.

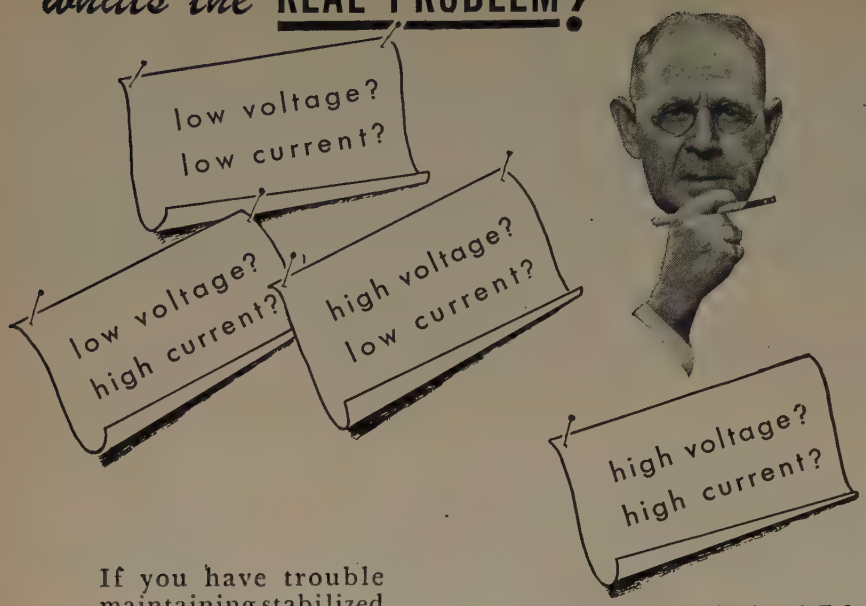
* Reg. U.S. Pat. Off.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 W. 42nd Street, NEW YORK 18 2700 W. Olive Avenue, BURBANK

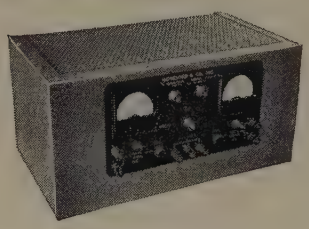
what's the REAL PROBLEM?



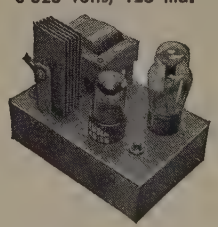
If you have trouble maintaining stabilized DC Voltage under changing Load conditions, it's time to investigate the Sorensen line of Nobatrons.

- **Common Nobatron Specifications:** Regulation Accuracy 0.2% from 0.1 load to full load; Ripple Voltage 1%; Recovery time 0.2 seconds under most severe load or input conditions; 95-130 VAC single phase 50-60 cycles: Adapter available for 230 VAC operation.
- **Ratings**
  Nobatron — 6, 12, 28, 48, 125 volts from 5—350 amperes
  B-Nobatron — 325, 500, 1000 volts — 125 ma.; 300 ma. & 500 ma.
  DC Standards — 2, 6, 15, 25, 50, 75, 150, 300 volts — 15, 30 and 50 ma.
- **Problems?** Sorensen Engineers are always at your service to help solve unusual applications.
- **Sorensen manufactures:**
  AC line regulators 60 and 400 cycles; Regulated DC Power Sources, Electronic Inverters; Voltage Reference Standards; Custom Built Transformers; Saturable Core Reactors.

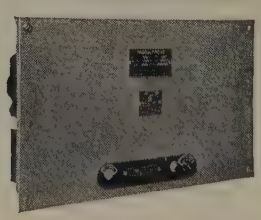
TYPICAL DC SOURCES



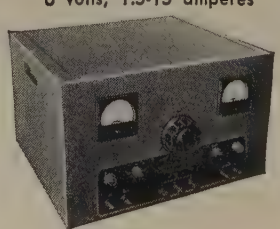
MODEL 325B
0-325 volts; 125 ma.



MODEL VS-50-50
50 volts @ 50 ma.



MODEL E-6-15
6 volts; 1.5-15 amperes



MODEL 500 B
0-500 volts; 300 ma.

WRITE TODAY For Catalog B1049 For The Complete Line And Prices.

POWER controlled converted *Sorensen* **and company, inc.**
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 40A)

350-Watt Isolation Transformer

A new isolation testing transformer has been announced by **Standard Transformer Corp.,** 3580 Elston Ave., Chicago 18, Ill., maker of Stancor transformers and related components. This new unit is rated at 350

watts and is large enough to handle almost any TV or radio receiver on test. It may also be used to correct a high or low line voltage. Three standard receptacles provide output voltages of 105-, 115-, and 125-, with 117 volts, ac, from the line.

Sub-Audio Coils

United Transformer Co., 150 Varick St., New York 13, N. Y., has specialized for many years in the manufacture of stable Hi-*Q* coils for audio and supersonic frequency work. They have now developed and make available to customers' specifications Hi-*Q* coils for subaudio frequencies.

These coils have Hi-*Q* and stable characteristics for frequencies from 0.1 to 10 cps. A typical unit provides an inductance of 300,000 hys. with *Q* of 10 at 0.15 cps and *Q* of 30 at 0.5 cps. This coil is designed for a 1 volt ac–0.1 ma dc circuit.

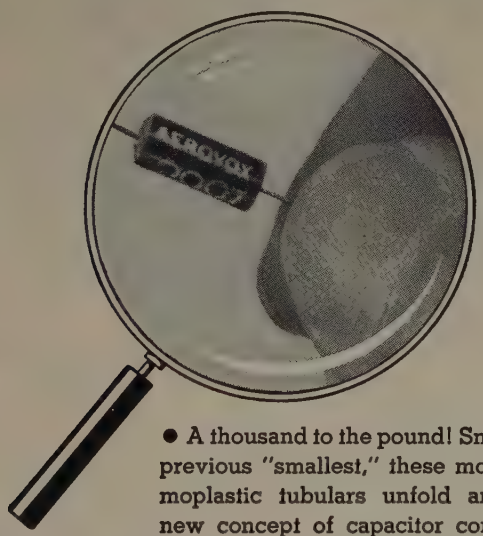
(Continued on page 44A)

Miniaturization Specialist Capacitors—

1000 to the Pound!

AEROVOX MICRO-MINIATURES

(TYPE P83Z AEROLITE* CAPACITORS)



● A thousand to the pound! Smaller than previous "smallest," these molded thermoplastic tubulars unfold an entirely new concept of capacitor construction. The smaller physical sizes are directly attributed to the latest metallized-paper technique which combines both dielectric and electrodes in a single winding strip. Unusually strong lead connections to capacitor section. Since capacitance is predetermined mechanically in the initial processing, it is no longer necessary to rely on the human element for capacitance control.

Type P83Z Micro-miniatures are particularly applicable to that portion of the electronic field where low capacitance paper capacitors and high-capacity disk capacitors are now being used.

*Trade-mark

Featuring . . .

Two sizes: 3/16" d. x 7/16" l.; 1/4" d. x 9/16" l.

200, 400 and 600 rated voltage; 300, 600 and 900 test voltage.

Hyvol K impregnated in humidity-resistant molded thermoplastic case.

Operating temperature from —15° C. to +85° C. without derating.

Power factor less than 1% when measured at or referred to frequency of 1000 cps and ambient temperature of 25° C.

Life test: 1000 hours at 1.25 times rated voltage in ambient temperature at 85° C.

Insulation resistance of 25,000 megohms or greater, measured at or referred to temperature of 25° C. Insulation resistance at 85° C., 500 megohms or greater.

● *Try Aerovox Micro-miniatures in your miniaturized assemblies. Write Dept. MM-83 for engineering data, samples, quotations and application-engineering aid.*

AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A.

Sales Offices in All Principal Cities • Export: 41 E. 42nd St., New York 17, N. Y.

Cable: AEROCAP, N. Y. • In Canada: AEROVOX CANADA LTD., Hamilton, Ont.

NEW! STANDARD SIGNAL GENERATOR

20 CYCLES TO 50 MC.
IN ONE INSTRUMENT!

THIS new *Laboratory Standard* is designed for the extremely wide frequency coverage of 20 cycles to 50 megacycles, employing two specially designed oscillators.

A low frequency oscillator, in the range from 20 cycles to 200 kilocycles, provides continuously variable, metered output from 0 to 50 volts across 7500 ohms. This is sufficient for most measurements at audio and supersonic frequencies. It may also be used as the modulator for the radio frequency oscillator.

A radio frequency oscillator covers the range from 80 kilocycles to 50 megacycles. It provides metered output, continuously variable with an improved mutual inductance type attenuator, from 0.1 microvolt to 1 volt. This voltage range makes possible most receiver measurements including the determination of a.v.c. characteristics and interference susceptibility.

SPECIFICATIONS:

Frequency Range: 20 cycles to 50 megacycles. (20 cycles to 200 kilocycles in four ranges; 80 kilocycles to 50 megacycles in seven ranges; plus one blank range.)

Frequency Calibration: Direct reading dial, individually calibrated for each range.

Frequency Accuracy: 20 cycles to 200 kilocycles, accurate to ± 5%. 80 kilocycles to 50 megacycles, accurate to ± 1%.

Output Voltage and Impedance: 0 to 50 volts across 7500 ohms from 20 cycles to 200 kilocycles. 0.1 microvolt to 1 volt across 50 ohms over most of the range from 80 kilocycles to 50 megacycles. (Improved mutual inductance type attenuator.) The output voltage or impedance of either range can be changed by the use of external pads.

Modulation: (80 KC—50 MC range) Continuously variable from 0 to 50% from 20 cycles to 20 kilocycles by internal low frequency oscillator or external source.

Harmonic Output: Less than 1% from 20 cycles to 20 kilocycles; 3% or less from 20 kilocycles to 50 megacycles.

Leakage and Stray Field: Less than 1 microvolt from 80 kilocycles to 50 megacycles.

Power Supply: 117 volts, 50 to 60 cycles. 75 watts.

Dimensions: 15" high x 19" wide x 12" deep, overall.

Weight: 50 lbs.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

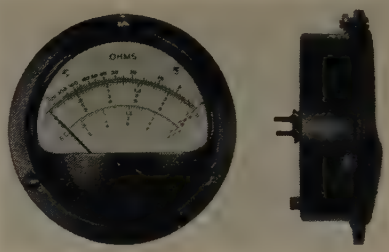
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 42A)

Hermetically Sealed Panel Meter

Marion Electrical Instrument Co., Manchester, N. H., announces a new 4½-inch instrument which brings the features of the Marion hermetic line to users who require a 4½-inch meter. A solder-type zero adjuster provides adjustment without breaking the hermetic seal. A rubber gasket is included for use as a pressure seal for panel mounting.



Extremely compact, this new meter has a depth of 1⅛ inches from front of panel to allow more freedom in installation. This type is now offered in a wide variety of standard ranges. Either 1 or 2 per cent accuracy rating available. Dials are standard or specially calibrated, depending on requirements.

New Locked-Flange Bobbins for Coils

Precision coil bobbins with a new plastic-coated core, and the flanges locked in place on this core by the plastic are being marketed by **Precision Paper Tube Co.,** 2045 W. Charleston St., Chicago 47, Ill. Thus, wire cannot be crowded on the bobbin, nor become loosened, as it does when loose flanges slide along the tube, or off it.

The manufacturer states that the new plastic-coated core makes the coil bobbins 15 to 20 per cent stronger, yet light in weight. It also increases the bobbins' insulating qualities and moisture resistance, and has excellent heat-dissipating qualities. Spiral-wound, this core can be made any size, any shape—round, square, or rectangular—and to any ID or OD with close tolerances.

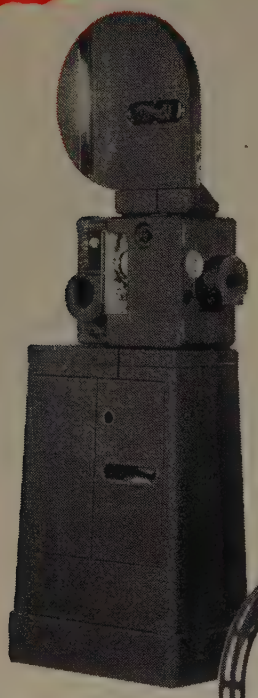
(Continued on page 46A)

Exclusive G.P.L. Development

LEADERS IN

Professional Quality Projection for 16 mm. Film

Telecast Projectors with the Basic Features and Performance Reliability of the Famous Simplex Theatre Projectors



Clearer Pictures... Finer Sound

from ANY Film in your Studio

The G.P.L. Model PA-100 is a heavy-duty studio film chain projector, for use with either iconoscope or image orthicon, which sets new standards of ruggedness and projection quality. The professional sprocket type pull-down is quiet and trouble free. It provides a vertical stability of better than 0.2%. Tests show more than 1,000 passages without noticeable film wear. The high quality optical system resolves better than 90 lines per mm., with the screen so uniformly illuminated that corner brightness is at least 90% of center.

- The sound system provides a frequency response truly flat to 7,000 cps, with flutter less than 0.2%.
- An enclosed, 4,000 foot film magazine provides for 110 minutes of projection—an entire feature.
- The film gate and optical and sound components are instantly removable.

A Portable that Pays for Itself in the Field

The G.P.L. General Utility Projector (PA-101) works directly with image orthicon studio or field cameras to provide new economy and convenience in your operations. For the small station, it provides the same quality as conventional iconoscope film chain equipment, using regular studio cameras. For large stations, its portability and high performance permit great flexibility, such as picking up commercials at remotes—games, sporting events, etc., without requiring studio standby facilities for this purpose.

It has the same performance features as the PA-100 except that a fast intermittent shutter provides illumination in relatively broad pulses at 120 cycles per second. This means that the projected picture may be picked up by a standard image orthicon camera without special phasing facilities. The projector weighs only 65 lbs. with case.

WRITE, WIRE OR PHONE FOR DETAILS...

TV Camera Chains • TV Film Chains
TV Field and Studio Equipment
Theatre TV Equipment

GENERAL PRECISION LABORATORY INCORPORATED

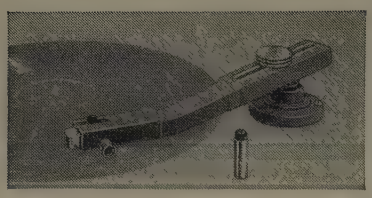
General Precision Laboratory

INCORPORATED

PLEASANTVILLE NEW YORK

THE NEW CLARKSTAN

ARMS WITH THE "SLIDE-IN" CARTRIDGE HOLDER

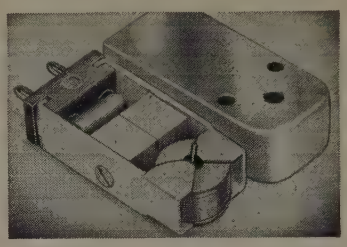


USES ANY TYPE CARTRIDGE

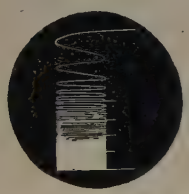
Never before such fine quality professional transcription and record arms designed to use any cartridge of your choice. Slotted so you need only slide the cartridge into the arm and a twist of the thumb screw secures the cartridge in place. No soldering. Positive electrical contact is maintained by a spring loaded plunger. A quick-acting weight adjustment and height adjustment for all turntable conditions gives accurate balance and proper needle force. These fine quality professional arms are the best yet for LP Microgroove and standard discs. Model 213G plays records up to 12" in diameter. Model 212G plays transcriptions up to 17" in diameter. See your jobber or write for Bulletin No. 173-4A.

WIDE RANGE RV PICKUP

Clarkstan RV wide range variable reluctance cartridge for best reproduction of LP Microgroove and standard records. Instantaneously replaceable and interchangeable needles permit use of a variety of styli. Frequency response to above 12,000 cps. Needle force 5-7 grams for LP Microgroove, as low as 10 grams for conventional records. Output 60 millivolts. High Impedance—5—50—250 and 500 ohm models available. ½" mounting centers. Supplied with sapphire stylus. Net price (cartridge only with standard sapphire stylus) $15.00. See your jobber or write for Bulletin No. 141-4A.



CLARKSTAN AUDIO SWEEP FREQUENCY TRANSCRIPTIONS



An entirely new method of making instantaneous frequency response runs. Audio Sweep Frequency Transcriptions embody all correction factors in the original recording which eliminates the need for charts and graphs. When used with an oscilloscope, the Audio Sweep Frequency Transcriptions (sweep rate 20 times per second) provide an instantaneous response measurement so a few quick adjustments on a circuit complete the job. Used extensively for testing audio amplifiers, loud speakers, microphones, accoustical networks, electrical filter networks, etc. Broadcast engineers can make frequent quick checks of transmission systems and components. Used for production testing. Locates distortion. Excellent for laboratories as well as FM stations, motion picture studio and theatre sound equipment. See your jobber or write for Bulletin No. 1044.

STEADY STATE FREQUENCY RECORDS

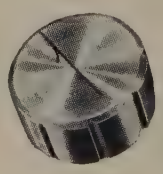
Clarkstan now offers three new test records which for the first time conform to exact specifications, permitting the user to work in known quantities. The reproduction of these fine test records involves no polishing and employs the very latest techniques which insures exact duplication of the original recordings in each pressing. Complete specifications of the original recordings are furnished. See your jobber or write for Bulletin No. 1811.

MICROSCOPE GROOVE ANALYZER

Low cost, medium power microscope with built-in light and reticle. Designed expressly for the phono record recorder. The illumination is optimum for observing the condition of the groove and the number of lines per inch and depth of cut. Has flat field, excellent optics—can be used with glasses (eyepoint is 1" above top). Both 20x and 40x provided in one microscope. Reticle for direct measurement by .002". Complete with lacquered wooden carrying case with sliding cover. Focusing is accomplished by means of friction sliding tube. Is easy and positive. Net price $22.50. See your jobber or write for Bulletin No. 185.

CLARKSTAN KNOBS

Attractive one-piece knobs accurately machined from DURAL add the professional appearance to control panels and all types of test equipment. All knobs have fluted sides and have screw-type mounting for round or flat shafts to fit standard ¼" shafts. Back of all knobs recessed ¾" diameter by 5/64" deep to accommodate panel bushing nut. Made in following diameters: 1"—1¼"—1½"—2" with or without pointer. See your jobber or write for Bulletin No. 182A.



CLARKSTAN CORP ELECTRONICS DIVISION 2R
11921 WEST PICO BOULEVARD
LOS ANGELES 64, CALIFORNIA

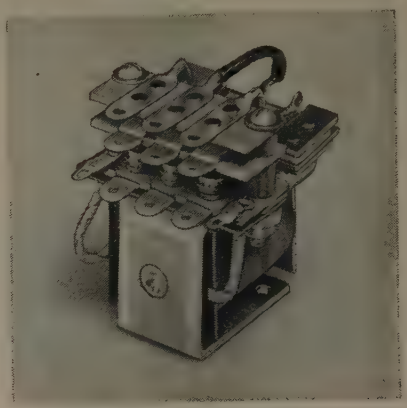
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 44A)

New Series of Relays

Recommended for applications where humidity or dust conditions present a hazard to continuous operation are the hermetically sealed relays recently introduced by the **Guardian Electric Manufacturing Co.**, 1621 W. Walnut St., Chicago 12, Ill.



These units are available in four standard mounting arrangements—the lug header type, Army-Navy connector type, octal plug type, and the screw terminal type. A wide variety of contact combinations and operating voltage ranges are available in the units now offered by this company as standard hermetically sealed equipment. The relay is shown above, below it is shown hermetically sealed.

Among the relays listed in the new Guardian Catalog 5-H are the well-known radio, telephone, and aircraft type relays. Through the development of a new method of sealing and the use of aluminum containers, the weight of these units is far less than those previously offered to industry. Included in the current catalog is technical information concerning the performance of units conforming to requirements of the ANR-20b and the 10-G vibration tests. Write for a copy of the catalog 5-H with information on hermetically sealed relays.

(Continued on page 48A)

What's Your PANEL INSTRUMENT Problem?

Simpson ENGINEERS WILL HELP YOU Solve It!

No matter what your panel instrument problem is, Simpson Electric Company engineers will be glad to help you solve it. Every day they are confronted with individual design problems.

Behind every Simpson instrument is a world-wide reputation for quality. Simpson movements have greater ruggedness and accuracy, because of the full bridge-type construction and soft iron pole pieces.

When Simpson helps you with your problem, you benefit from this world-wide reputation and the years of experience of Simpson engineers.

Let Simpson engineers help you with your next instrument problem and for your standard instrument requirements take advantage of our large stock, available for immediate delivery.

SIMPSON ELECTRIC COMPANY 5200-18 WEST KINZIE STREET, CHICAGO 44, ILLINOIS
IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO

you need these FOUR... no more!

THE BLUE ZEPHYR BELL LAMP
Ideal for over-all illumination. Light-weight, sturdy construction. 750 to 2000 watt, range in P. S. 52, 1000-hr. globe. Folding leg stand, and diffuser. Blue wrinkle finish.

THE BLUE ZEPHYR BABY
A full size 750 watt Baby Spot that is interchangeable from the auxiliary stand to the Blue Comet Boom (as shown above). Contains all the features and accessories of the Blue Zephyr Junior, shown below. Blue wrinkle finish.

THE BLUE ZEPHYR JUNIOR
The finest in modern lighting equipment. Lamp head features include interlocking ventilation channels, direct-action focusing with graduated scale. Attached rotating barn doors and full-size diffuser frame. Stand has folding legs with rubber-tired ball-bearing casters. Adjustable from 51 inches to 113 inches. Blue wrinkle finish.

THE BLUE COMET BOOM
Stand extends to 8 feet-10 inches; has air brake for ease in lowering. Boom arm adjustable from 5 feet-4 inches to 8 feet-1 inch. Positive locking fittings. Boom and stand fold flat for compact handling. Flexible, quiet. Blue wrinkle finish.

WRITE TODAY FOR OUR NEW CATALOGUE ON LIGHTWEIGHT LIGHTING

THE EMBLEM
A BLUE MONOGRAM PRODUCT
OF ACHIEVEMENT

MOLE-RICHARDSON CO.

937 NORTH SYCAMORE AVENUE
HOLLYWOOD 38, CALIFORNIA

News New—Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 46A)

Stabilized DC Indicating Amplifier

Multi-purpose stabilized dc indicating amplifiers just announced by **Leeds & Northrup Co.**, 4934 Stenton Ave., Philadelphia 44, Pa., are useful for low-level dc measurements as direct-reading microvoltmeters or micromicroammeters; as recorder pre-amplifiers to extend the range of standard Speedomax recorders; and as high-sensitivity, short-period null detectors in place of galvanometers. Amplifiers are supplied either as voltage or current type, with choice of zero-left or zero-center built-in 4-inch indicating meter.

Both gain and zero point are so highly stabilized by a combination of ac amplification and dc null-balance feedback that trimmer controls are unnecessary. Without impairing performance, the voltage amplifier can be used with sources up to 10,000 ohms resistance, and the current type with sources of 100,000 ohms and higher.

Basic range of the voltage amplifier is 0 to 50, or −25 to +25 microvolts, with scale multipliers of 1, 2, 4, 10, 20, and 40; of the current amplifier, 0 to 1,000 or −500 to +500 $\mu\mu$a, with multipliers of 1, 2, 5, 10, 20, 50, 100, 200, 500, 1,000, and 2,000. Response time of both models is 2 to 3 seconds. Output at recorder connector for full-scale input on any range is 10 mv at output impedance of 500 ohms.

For convenience in null balance measurements, the indicating meter can be switched to non-linear response.

For full details, write to the manufacturer.

400 CPS Chopper

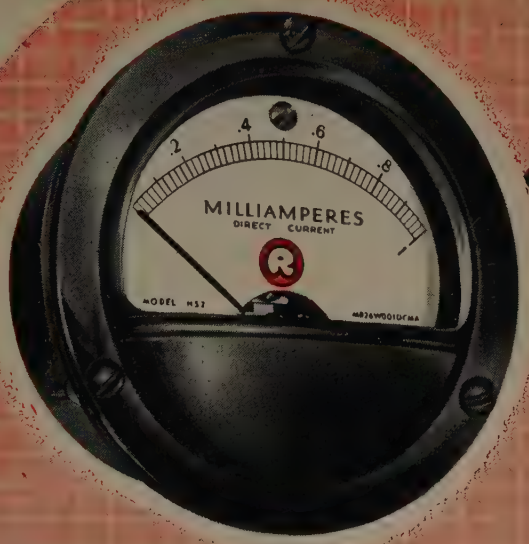
A 400-cps chopper is now being offered to the industry by **Airpax Products Co.**, 1024 Greenmount Ave., Baltimore 2, Md.

This component is offered at 6, 12, 26, 32, and 120 volts dc, or 120 volts ac.

The manufacturer claims that life tests of between 3,000 and 6,000 hours have been recorded. However, it is being marketed with an expected life of 1,000 hours or better.

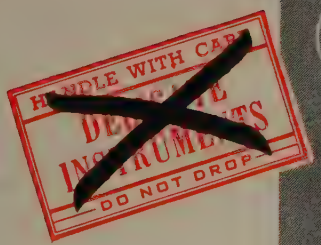
When an external 0.04 μf capacitor is in series with the coil, the chopped output is in phase with the driving signal. The capacitance tolerance is not critical. Without correction the output lags approximately 65°. The chopper is adjusted for the frequency range of 380 to 420 cps.

(Continued on page 56A)



setting new standards for electrical instruments

MARION RUGGEDIZED METERS



Manufacturers of Hermetically Sealed Meters Since 1944

This amazing new family of Marion ruggedized electrical indicating instruments sets new standards of quality and accuracy in electrical measurement. Marion "Ruggedized" instruments give better performance in *any* application. Use them with confidence even where you never before dared use "delicate instruments." They exceed all JAN-I-6 requirements, are *hermetically sealed* and completely interchangeable with existing JAN 2½" and 3½" types.

Marion Ruggedized instruments perform perfectly under critical conditions of shock, vibration, mechanical stress and strain. Hermetic sealing makes them impervious to weather and climate.

When you want the *best* in meters for any application — from bulldozers to Geiger Counters — insist on Marion, the name that means the most in meters.

Send for our booklet on Marion Ruggedized Instruments. Marion Electrical Instrument Company, 407 Canal Street, Manchester, New Hampshire.

MARION MEANS THE MOST IN METERS

Canadian Representative: Astral Electric Company, 44 Danforth Road, Toronto, Ontario, Canada

Export Division: 458 Broadway, New York 13, U.S.A., Cables MORHANEX

marion meters

SCIENTISTS AND ENGINEERS

for
challenging research and advanced development in fields of

RADAR
GYROSCOPES
SERVOMECHANISMS
MECHANICAL SYSTEMS
ELECTRONICS CIRCUITS
APPLIED PHYSICS AND MATH
PRECISION MECHANICAL DEVICES
ELECTRICAL SYSTEM DESIGN
GENERAL ELECTRONICS
INSTRUMENTATION
MICROWAVES
COMPUTERS
AUTOPILOTS

Scientific or engineering degree and extensive technical experience required.

WRITE:
Manager, ENGINEERING PERSONNEL
BELL AIRCRAFT CORPORATION
P.O. Box 1, Buffalo 5, N.Y.

Senior Electronic Circuit Physicists

for advanced Research and Development

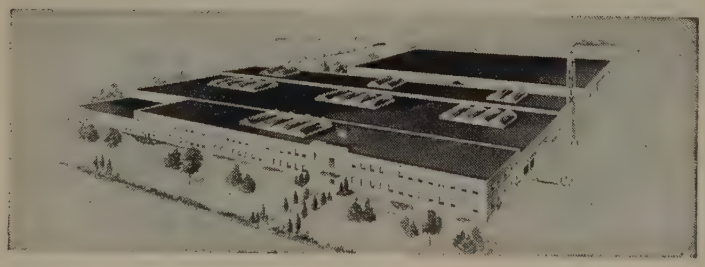
Minimum Requirements:

1. M.S. or Ph.D. in Physics or E.E.
2. Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.
3. Minimum age 28 years.

RESEARCH AND DEVELOPMENT LABORATORIES
Hughes Aircraft Company
Culver City, California

ELECTRONIC ENGINEERS

BENDIX RADIO DIVISION
Bendix Aviation Corporation



PRODUCTION DESIGN RESEARCH

Bendix Radio Division, a leader in the field of high quality radar and communications equipment, has positions for engineers experienced in the design and development, for production, of radio and radar equipment or electronic research.

Positions are available at all salary levels.

Good advancement opportunities, air-conditioned plant in suburban location, excellently equipped laboratories, technical library, large experimental engineering model shop.

Housing and rentals in Baltimore are plentiful.

Interviews will be held in Baltimore, Chicago and New York. Please send resume of experience promptly to:

MR. W. L. WEBB, *Director* Engineering and Research
BENDIX RADIO DIVISION
Bendix Aviation Corporation • Baltimore 4, Maryland

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

TELEVISION ENGINEERS

Television engineers with at least 3 years resign experience, preferably electrical engineering, as production engineer for nationally known radio and TV manufacturer located in upper New York state. Box 612.

ANTENNA ENGINEER

Long Island laboratory has an opening that is unusually suitable for an engineer who prefers a small company, is interested in specializing in VHF and microwave antennas and who has carried real responsibility in this or closely related field. Box 614.

ACOUSTIC ENGINEER

For research and design on loudspeakers and microphones. Must have a thorough background in acoustics, audio and measuring techniques, with a minimum of 5 years laboratory or practical design experience on loudspeakers or transducers. Progressive manufacturer in New York suburban area. Send complete resume and state salary requirements. Box 415.

RADIO ENGINEER

Electrical or radio engineer, must have development experience in audio frequency circuit design. Acoustical experience also helpful. State experience, age, salary desired. Box 616.

ELECTRONIC ENGINEER

At least 5 years post-college experience in development DC amplifier, digital computers, pulse and servo design. Established company. Classified work. New York City. Box 617.

PROFESSOR

Professor of communications engineering needed for fall 1950 southeastern university. Will be in charge of graduate work and research activities. $6.50 for nine months with extra income for summer teaching, or sponsored research. Must have Ph.D. or D.Sc. degree. Write Box 618.

JUNIOR ELECTRICAL ENGINEER

Attractive opportunity for junior electrical engineer with manufacturer of UHF equipment. Preferably a man with one or two years experience. Reply to Box 619.

PROJECT RADIO ENGINEER

To take responsible charge of design of radio communications systems between Hawaiian Islands. Experience in VHF and microwave links design desirable. College training or equivalent necessary. Live in Honolulu. Contact Mutual Telephone Co. Box 2200, Honolulu, T.H.

(Continued on page 51A)

RESEARCH ENGINEERS ELECTRICAL ENGINEERS AND PHYSICISTS

THE FRANKLIN INSTITUTE LABORATORIES FOR RESEARCH AND DEVELOPMENT

Have opening for personnel with 2-10 years experience. Advanced degrees are desirable in certain of the positions. Fields of interest covered are: Mathematical Analysis of Physical Problems, Statistical Theory of Communications, Electromagnetic Theory, Circuit Analysis, Servomechanism Theory, Electrical Computing, Advanced and Fundamental Circuit Development, Radar and Pulse Circuits, Supervision of Operation of G.C.A. or Tracking Radar, Air Traffic Control, Air Navigation, Automatic Controls, Industrial or Marine Power Drives, and Electrical Machinery.

Send resume of education and experience, salary requirements and a photograph to:

Personnel Department
THE FRANKLIN INSTITUTE
Philadelphia 3, Pennsylvania

PHYSICISTS AND ENGINEERS

You can find plenty of positions where you will work on minor improvements on radar, telemetering systems, and other conventional devices. However, you will find very few positions where you can break ground in new fields having tremendous significance. This you can do at the JACOBS INSTRUMENT COMPANY, whose entire effort is devoted to pioneering activities in new fields that it has opened up itself. One of these fields, for example, is that of ultra-high speed, ultra-compact digital computers and controllers. This company's JAINCOMP family of computers dominates this field. Other equally important fields are being developed. Engineers and physicists with sound backgrounds and experience in the design of advanced electronic circuits or precision mechanical instruments may qualify, also individuals with good backgrounds in applied physics. A few openings exist for outstanding junior E. E.'s and physicists, also experienced technicians; applicants for these positions must apply in person.

JACOBS
INSTRUMENT CO.
4718 Bethesda Ave.
Bethesda 14, Maryland

POSITIONS OPEN

(Continued from page 50A)

ENGINEER

Chief systems test engineer with practical experience in electro-mechanical and hydraulic systems to direct systems testing on guided missiles. Familiarity with production testing techniques and test equipment in above fields is desirable. Excellent opportunity for someone who can organize a rapidly expanding facility. Direct inquiries to Manager, Engineering Personnel, Bell Aircraft Corp., P. O. Box 1, Buffalo, N.Y.

SPECIFICATION WRITERS

Specification writers capable of clear, concise technical description of the design, construction and testing of missile and electronic equipment. Knowledge of military specifications and familiarity with aircraft and electronic components is essential. Direct inquiries to Manager, Engineering Personnel, Bell Aircraft Corp., P.O. Box 1, Buffalo 5, N.Y.

ENGINEER

Engineer, electrolytic capacitor, at least 5 years experience in design and development. Write resume of experience and salary expected. Box 620.

RADIO ENGINEER

Radio engineer wanted by prominent Chicago electronic manufacturer to design and supervise manufacture of full line of commercial amplifiers. Must have engineering degree or equivalent and minimum of 2 years design experience in commercial P.A. systems. Give details including age, education, experience, reference, availability and salary expected. Box 621.

ENGINEER

Excellent opportunity for engineer to apply microwave measurements and techniques to development and manufacture of magnetrons and klystrons. Pulse circuit knowledge also valuable. B.S. degree and experience or advanced degree with heavy concentration on above required. State salary expected and qualifications. Location New York City. Box 622.

CIRCUITS ENGINEER

Rapidly expanding company in instrumentation field has opening for senior engineer. Prefer man with masters degree and 4 or more years of experience in design of pulsing circuits, VHF and UHF. Excellent opportunity for man who can meet requirements. Location Brooklyn. Send complete resume to Box 623.

PHYSICIST

Physicist for fundamental electron tube research. Should be familiar with techniques of producing photo-electric, secondary emissive and fluorescent screens, experience with electron-optics, physical optics and solid state physics an advantage. Box 624.

SALESMAN

Salesman to organize and promote sales of high quality radio resistors now being produced by a company well established in radio and electrical component industry. Give summary of experience and availability in reply. Box 625.

(Continued on page 52A)

ELECTRONICS TECHNICIANS

for

RADAR, COMMUNICATIONS, TELEVISION RECEIVERS

Needed by

RCA Service Co., Inc.

A Radio Corp. of America Subsidiary for U.S. & Overseas

Requirements:

- **Good Character**
- **Training in Installation or Maintenance of Radar, Communication or Television**
- **Give Full Details of Practical Experience**

QUALIFIED CANDIDATES WILL BE INTERVIEWED PROMPTLY

Compensation:

Up to $7,000.00 a Year to Start. For Overseas Assignment, With Periodic Review of Base Salary Thereafter Made Up of—

- **Base Salary**
- **Overseas Bonus**
- **Actual Living & Other Expenses**
- **Accident, Hospitalization and Life Insurance**
- **Vacation & Holiday Pay**

Qualified technicians seeking connection with leading company having permanent program for installation and service of military equipment, AM, FM, TV transmitters and receivers, and electronic devices, such as electron microscopes, mobile and microwave communications, theatre TV, write full history to:

RCA
SERVICE COMPANY, INC.
Camden 2, New Jersey

Positions available for

SENIOR ELECTRONIC ENGINEERS

with

Development & Design Experience

in

MICROWAVE RECEIVERS
PULSED CIRCUITS
SONAR EQUIPMENTS
MICROWAVE COMMUNICATIONS SYSTEMS

Opportunity For Advancement Limited only by Individual Ability

Send complete Resume to:
Personnel Department

MELPAR, INC.
452 Swann Ave.
Alexandria, Virginia

ENGINEERS

RESEARCH AND DEVELOPMENT

Career Positions
for
Top Engineers and Analysts

SENIOR ELECTRONICS AND ELECTRONICS ENGINEERS—B.S. or M.S. degree; 2 to 7 years experience in radar, television, pulse, video or display circuit design.

DIGITAL COMPUTER DESIGN ENGINEERS

AUTOMATIC TELEPHONE SWITCHBOARD DESIGN ENGINEER

SENIOR ELECTRO-MECHANICAL ENGINEERS—Degree and at least 4 years experience in servo-mechanism analogue computers, special weapons or system design.

For Interview
Contact Martin Representative Attending
I.R.E. West Coast Convention
September 13-15
Long Beach, California
or
Submit detailed resume to:

THE GLENN L. MARTIN COMPANY
Employment Department
Baltimore 3, Maryland

POSITIONS OPEN

(Continued from page 51A)

ASSISTANT PROFESSOR AND INSTRUCTOR

Strong eastern college has opening for Assistant Professor and Instructor in electrical engineering. Master of Science in electrical engineering is required, and industrial experience is desirable. Send resume of qualifications, references and salary required. Box 626.

PHYSICISTS & ENGINEERS

Cornell Aeronautical Laboratory, an affiliate of Cornell University, has permanent positions open in fields of pure and applied physics for men of project engineer caliber with advanced degrees and experience in physics, applied mathematics, electronics, and mechanical instrument design. The position of our laboratory is between those of universities and commercial research institutes, and combines, we believe, many of the traditional advantages of both. Inquiries confidential; address Mr. Nathaniel Stimson, Dept. R, Cornell Aeronautical Lab. P.O. Box 235, Buffalo 21, N.Y.

ENGINEER

Well known German radio manufacturer has immediate opening for engineer with design and development experience in FM-TV equipment. Factory situated in mountainous part of Southern Germany (US Zone) with pleasant living conditions (summer and winter sports). German language desirable. Please write to Z.G. 931, ANNONCEN-EXPEDITION CARL GABLER GMBH, Munich, Germany.

ELECTRONIC PHYSICIST

Electronic Physicist for research and development work on instrumentation problems with major petroleum refiner. Degree in physics essential, M.S. or Ph.D. preferred. Must have a minimum of 5 years' research experience on a variety of electronic problems and demonstrated ability to develop new and ingenious electronic devices. Age 28-40. Location Chicago. Salary dependent upon training and experience. Reply in confidence giving full details to Box 627.

NATIONAL UNION RESEARCH DIVISION

Electrical Engineers and Physicists are needed for research on Cathode Ray, Subminiature, Secondary Emission and other types of Vacuum Tubes.

Permanent interesting positions are available in the following fields:

Tube design & development
Tube processing
High vacuum systems
Solid state physics
Electron optics
Phosphorescence

Men qualified in any of the above are invited to send their resumes to:

Divisional Personnel Manager
National Union Research Division
350 Scotland Rd., Orange, N.J.

RCA VICTOR
Camden, N. J.

Requires Experienced Electronics Engineers

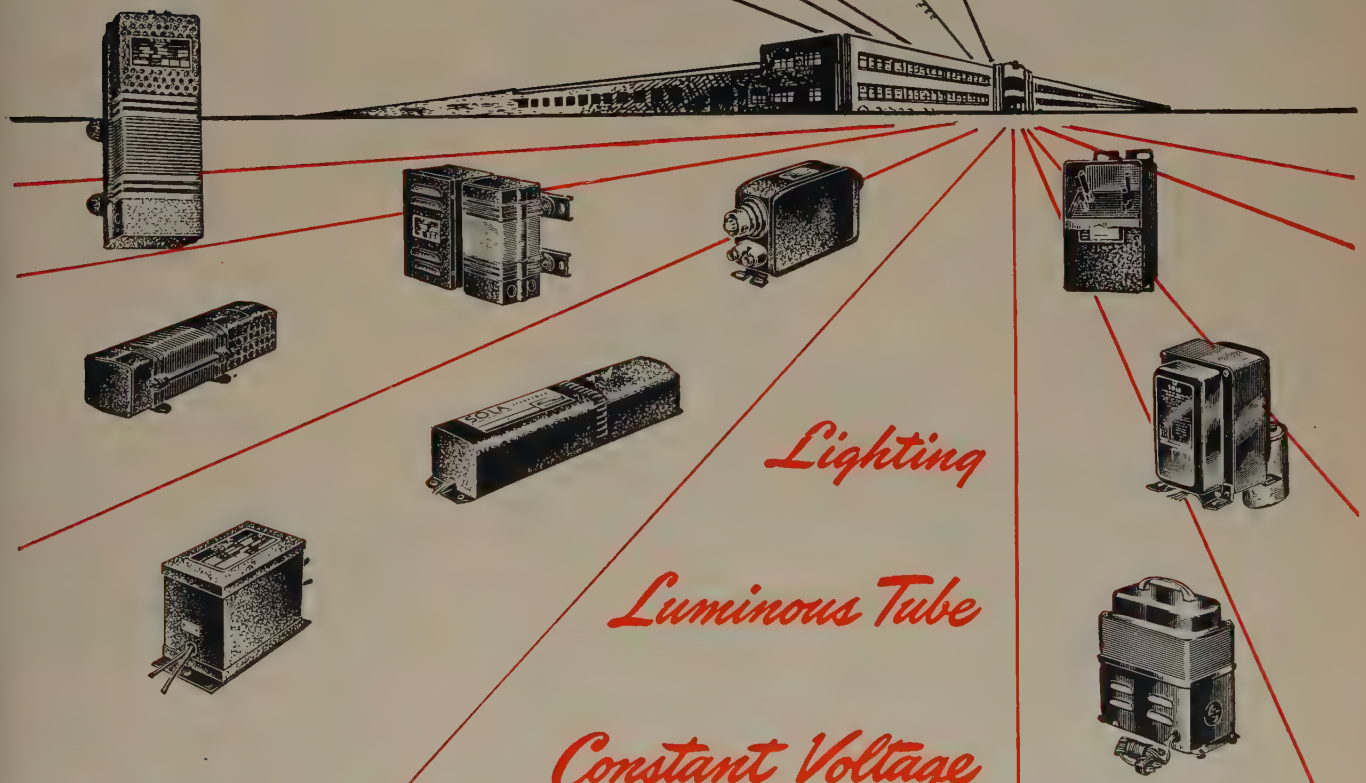
RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 950, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

20 Years of ENGINEERING LEADERSHIP in the SPECIALTY TRANSFORMER FIELD



Lighting

Luminous Tube

Constant Voltage

SOLA TRANSFORMERS

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • **SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois**

THE WIDE BAND POCKETSCOPE

BY WATERMAN

MODEL S-14-B

Wt. 14 lbs.
12" x 6" x 7"

Another Waterman POCKETSCOPE confirming the obsolescence of conventional oscilloscopes. Characterized by wide band amplifier fidelity without peaking as well as amazing portability. S-14-B POCKETSCOPE is ideal for laboratory and field investigation of transient signals, aperiodic pulses, or recurrent electrical wave forms.

Vertical channel: 50mv rms/inch, with response within −2DB from DC to 700KC, and pulse rise of 0.35μs. Horizontal channel: 0.3v rms/inch with response within −2DB from DC to 200KC, and pulse rise of 1.8μs. Non-frequency discriminating attenuators and gain controls, with internal calibration of trace amplitude. Repetitive or trigger time base, with linearization, from ½cps to 50KC, with ± sync. or trigger. Trace expansion. Filter graph screen. Mu metal shield. And a host of other features.

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

WATERMAN PRODUCTS INCLUDE:

S-10-B GENERAL	POCKETSCOPE
S-11-A INDUSTRIAL	POCKETSCOPE
S-14-A HI-GAIN	POCKETSCOPE
S-15-A TWIN TUBE	POCKETSCOPE
S-21-A LINEAR TIME BASE	

Also RAKSCOPES, LINEAR AMPLIFIERS, RAYONIC® TUBES and other equipment

WATERMAN PRODUCTS

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

ELECTRONIC ENGINEER

B.S.E.E. June 1950, University of Missouri. Age 26, top one-eighth of class, Eta Kappa Nu. 3 years research laboratory technician, 2 years broadcast Chief Engineer, active HAM. Interested in development, design or application. Box 430 W.

INSTRUCTOR

B.S. and M.S. in E.E. Desires teaching position in electrical engineering. Available September 1950. Member Phi Kappa Phi, Eta Kappa Nu, Tau Beta Pi. 1 year teaching experience as full time instructor. Age 24. Married. Box 442 W.

ELECTRONIC ENGINEER

B.S. in physics, June 1950, John Carroll University. Age 23. 1 year experience as Navy radio technician and 6 years radio repair part time. Desires position in development or research. Box 443 W.

JUNIOR ENGINEER

B.S.E.E. June 1950, New York University. Desires position preferably in electronics or communication fields. 3 years Army experience as aircraft mechanic with some work on radar equipment installation and maintenance. Age 29, married, one child. Box 444 W.

COMMUNICATIONS TEACHER

Assistant Professor in electrical engineering department of southern university desires similar position in east or north, teaching electronics and communications principles. B.S., M.A., M.S.E.E. (1948), University of Illinois 4 years' teaching Signal Corps schools. 8 months research on electronic timing. Age 30, married, 2 children. Eta Kappa Nu, Sigma Xi. Box 445 W.

LIAISON ENGINEER

Age 31, qualified to establish liaison group for coordinating production and design. B.S.E.E. (Night School), 3½ years on development of PTM systems, 2½ years electronic piece part production, 2½ years systems installation and engineering, 2 years 1st class wireman and mechanic, 20 months as RTIC in Navy. Box 447 W.

(Continued on page 55A)

PROJECT ENGINEERS

Real opportunities exist for Graduate Engineers with design and development experience in any of the following: Servomechanisms, radar, microwave techniques, microwave antenna design, communications equipment, electron optics, pulse transformers, fractional h.p. motors.

SEND COMPLETE RESUME TO EMPLOYMENT OFFICE.

SPERRY GYROSCOPE CO.
DIVISION OF
THE SPERRY CORP.
GREAT NECK, LONG ISLAND

RESEARCH
DEVELOPMENT
ENGINEERING

•

A progressive electronic research and development organization, contemplating expansion of personnel and facilities in an Eastern research center, is interested in contacting qualified engineering and scientific personnel experienced in electronics, physics, mechanics and administration.

Send complete resumes

to

THE APPLIED SCIENCE CORPORATION OF PRINCETON
P.O. BOX 44 PRINCETON, N.J.

Positions Wanted

(Continued from page 54A)

ELECTRONIC ENGINEER

Electronic engineer, graduated M.I.T. 1943 with B.S. and M.S. degrees, specializing in pulse communications systems. Desires permanent position. Box 448 W.

ELECTRICAL ENGINEER

B.S.E.E. June 1950, Newark College of Engineering, top 10%. Tau Beta Pi. Navy ETM; Reserve AETM. Age 23. Single. Summer experience wiring and drafting. Well qualified for position in development of electronic equipment. Box 449 W.

JUNIOR ENGINEER

B.E.E. Cooper Union, majored in electronics, graduated June 1950. Military service work on automatic pilots, amplifiers, gyros, etc. for 1 year. Also 1 year of work on aircraft transmitters and receivers as technician. Amateur Radio Class A license for past 6 years. Desires position in electronics or electro-mechanical field. Age 24. Box 450 W.

ELECTRICAL ENGINEER

Recent graduate of leading Canadian university. B.Sc.E.E. 5 years as radar technician in Air Force. Practical electrical background. Married, veteran. Interested in production of sales. Location secondary. Available immediately. Box 451 W.

ENGINEER

B.S.E.E. June 1950. New Mexico A. & M., communications major. 3 years experience Air Force radio and radar mechanic. Age 34, married, 1 child. Speak, understand and write Spanish. Would accept job in Latin America. Box 458 W.

COMMUNICATIONS ENGINEER

B.S.E.E. University of Michigan, February 1950. Age 25, married, 2 children. 3 years Navy aircraft radio operator and maintenance. Desires communications, electronics, or sales work anywhere in U.S. Box 459 W.

STATISTICAL QUALITY CONTROL ENGINEER

B.S.E.E. MIT, plus statistical quality control, mathematics statistics, methods, accounting and time study at Columbia. Experience: 4 years industrial field coordination engineer; 4 years inspection administration, Lt. Commander. Desires position as liaison with production, inspection, engineering and sales for quality div. Member ASQC. Box 460 W.

ENGINEER

M.S.E.E., MIT, Tau Beta Pi, Sigma Xi. Age 29. 2 years experience in radar while in service. 3 years experience in microwave measurements and developments. Desires electrical engineering teaching position in midwest. Box 461 W.

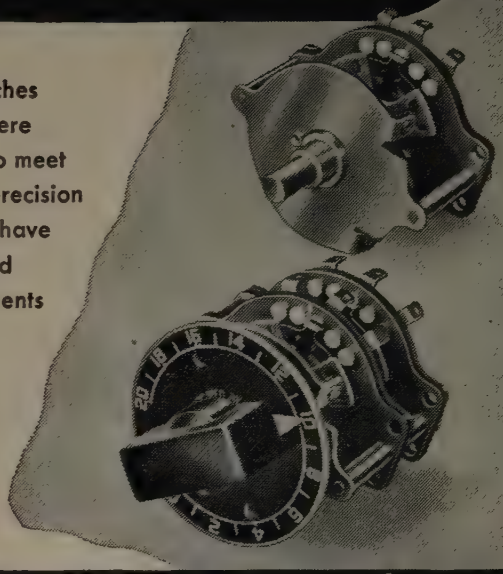
SALES OR APPLICATION ENGINEER (JR.)

B.E.E. June 1950, Pratt Institute; age 24; married. Former AETM 3/c, radio and radar service in U. S. Navy. Interested in sales or application. Hard, willing worker. Any location in U.S. or Alaska. Resume. Box 462 W.

(Continued on page 56A)

New Type 2A TAP SWITCHES

HAVE A CONSTANT CONTACT RESISTANCE OF ONLY 1 or 2 MILLIOHMS!



These high quality switches with up to 24 contacts were specifically developed to meet the need for rugged precision instrument switches that have longer operating life and are economical components in competitively priced electronic instruments and military equipment.

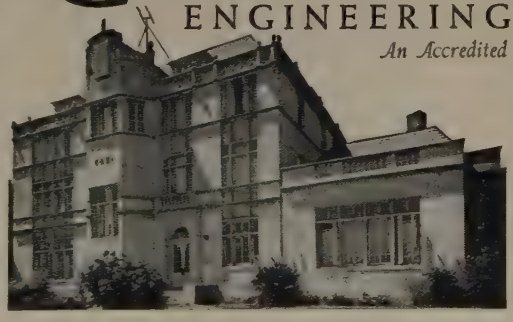
Write for Technical Bulletin No. 28.

TECH LABORATORIES PALISADES PARK NEW JERSEY

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute



ADVANCED HOME STUDY AND RESIDENCE COURSES IN PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING

Request your free home study or resident school catalog by writing to:

DEPT. 269B
16th and PARK ROAD, N.W.,
WASHINGTON 10, D.C.

Approved for Veteran Training

Engineers—Physicists

- *What do you want in a position?*
- *What are your aims and ambitions?*

SENIORS

The W. L. Maxson Corporation offers special opportunities if you are heavily experienced in research and development on radar, computers and associated equipment.

Please address your job requirements and résumé to A. Hoffsommer for individual attention.

THE W. L. MAXSON CORPORATION
460 W. 34th Street New York 1, N.Y.

PEAK Attenuation Efficiency

ACE Custom-Built SCREEN ROOMS

COVER THE ENTIRE RADIO FREQUENCY SPECTRUM

Tests and evaluations of present-day electronic equipment call for reducing the area background level of radio interference to a far greater extent than is possible with any ordinary screen room or shielded enclosure. Specialists in this exacting field since the early days of World War II, ACE offers both the know how and the production facilities. Attenuations of 140db.—and higher—at frequencies as low as 0.15 and as high as 10,000 mc. are readily obtainable in our custom-built rooms. Put your screening problem up to ACE. Write, wire or 'phone for details.

STANDARD "CELL TYPE" SCREEN ROOMS

Nine out of ten laboratory or production shielding problems can be solved fast and economically by ACE pre-built "cell-type" screen rooms. Minimum attenuations as high as 100 db. are obtained from 0.15 to 1000 mc. Easy to erect, enlarge or move. Fully proved. Low in price. Write for data bulletin.

ACE ENGINEERING & MACHINE CO., Inc. ACE

3644 N. Lawrence Street

PHILADELPHIA 40, PA. REgent 9-1019

Positions Wanted

(Continued from page 55A)

ELECTRONIC ENGINEER

B.E.E. June 1950, upper fifth, Syracuse University. Married, 1 child. Experience in radio, radar and antenna research. Interested in television, electronics, radio communication. Location anywhere in U. S. Box 467 W.

JUNIOR ENGINEER OR LABORATORY TECHNICIAN

Speciality precision instruments. 5 years experience on development of photoelectric instruments, electrocardiographs, timers, pulse transmitters and control systems. 3 years engineering college at Pratt Institute and New York University. Desires position in design or development work. Box 468 W.

COMMUNICATIONS ENGINEER

7 years experience in communications and VHF control systems in CAA and Army. 2 years at supervisory level. Graduate C.R.E.I. Married. Age 26. Interested in VHF-UHF design or development. Location immaterial. Available Sept. 15. Box 469 W.

ENGINEER

B.A. New York University, physics and psychology majors; graduate RCA Institute; age 33; 6 years broadcast engineering, 4 years teaching physics, both with administrative responsibilities. Seeks position in engineering administration, New York City location to permit continuing graduate study. Available Oct. 1. Box 470 W.

ELECTRONICS ENGINEER

B.S. Applied Physics. Graduated U.C.L.A. August 1950. 3 years as Army electronic technician. Desires position in industrial electronics with good future. Prefer west coast. Married. Age 26. Box 471 W.

ELECTRICAL ENGINEER

B.S.E.E. June 1950, Polytechnic Institute of Brooklyn. Age 26, single. F.C.C. radio phone license. 3 years electronic experience including design, construction and testing; 6 months radio repairman in Air Corps. Interested in sales, service, development or broadcast engineering. Resume on request. Box 472 W.

JUNIOR ELECTRONIC ENGINEER

B.S.E.E. June 1950, New York University. Age 23, single. 14 months Army. Attended Signal Corps school. 5 years radio and some television set repair part time. Desires communication or electronic work anywhere in U. S. Box 473 W.

ENGINEER

B.E.E.; M.E.E. August 1950, Syracuse University. Age 23, single. Communications major. 1 year Navy electronics technician, 1 year laboratory instructor. Tau Beta Pi, Pi Mu Epsilon, Sigma Pi Sigma. Desires communications work. Salary and location secondary. Box 474 W.

PHYSICISTS AND SENIOR RESEARCH ENGINEERS

POSITIONS NOW OPEN

Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

- Microwave Techniques
- Moving Target Indication
- Servomechanisms
- Applied Physics
- Gyroscopic Equipment
- Optical Equipment
- Computers
- Pulse Techniques
- Radar
- Fire Control
- Circuit Analysis
- Autopilot Design
- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

NORTH AMERICAN AVIATION, INC.
Aerophysics Laboratory
Box No. N-4, 12214 South Lakewood Blvd.
Downey, California

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Recent Catalogs

• • • A fifteen-page folder in color describing the services and products of **Hermetic Seal Products Co.,** 29-37 S. Sixth St., Newark 7, N. J. They offer multiple headers—terminals in all shapes.

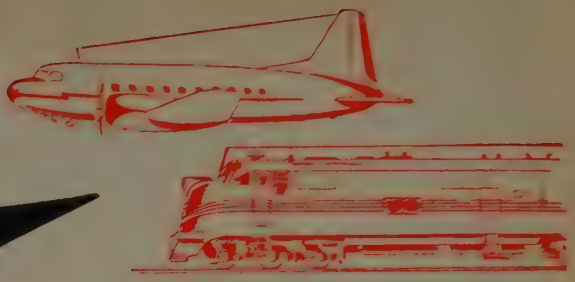
• • • 1950 Catalog 20-A, which describes all the instruments which **Hewlett-Packard Co.,** 395 Page Mill Rd., Palo Alto, Calif., regularly manufactures. Sales, service, and prices are quoted in the booklet.

• • • 1950 Catalog K, with a complete line of industrial, laboratory, and prospecting nuclear measurement equipment, is available on request from **Nuclear Instrument & Chemical Corp.,** 223 W. Erie St., Chicago 10, Ill.

• • • A new edition, the seventh, of the Stancor television catalog and replacement guide, Form 338, is available from **Standard Transformer Corp.,** 3580 Elston Ave., Chicago 18, Ill.

(Continued on page 59A)

HERE'S USEFUL AND IMPORTANT INFORMATION FOR *You!*



Type	Description	Typical Service	Prototype	Construction	Heater Volts	Heater Amps.	Plate Volts	Plate Ma.	Grid Volts	Screen Volts	Screen Ma.	Amp. Factor	Mut. Cond.
2C50	Dual Power Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	300	12.5	−24	—	—	9.5	1750
2C52	Dual Amplifier Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	250	1.3	−2	—	—	90	1900
6AK5W	Pentode RF Amplifier	Military Ruggedized	6AK5	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
6AL5W	Dual Diode	Military Ruggedized	6AL5	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			to 9 ma. dc. per plate			
6AS6W	Pentode RF Mixer	Military Ruggedized	6AS6	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
6C4W†	RF Power Triode	Military Ruggedized	6C4	7 pin miniature	6.3	0.15	250	10.5	−8.5	—	—	17	2200
6J5WGT	General Purpose Triode	Military Ruggedized	6J5GT	Bantal	6.3	0.3	250	9	−8	—	—	20	2600
6J6W†	Dual AF-RF Triode	Military Ruggedized	6J6	7 pin miniature	6.3	0.45	100	8.5	Rk 50	—	—	38	5300
6SA7WGT†	Pentagrid Converter	Military Ruggedized	6SA7GT	Bantal	6.3	0.3	250	3.5	Rg 20000	100	8.5	—	450 Conv. Cond.
6SJ7WGT†	Pentode RF Amplifier	Military Ruggedized	6SJ7GT	Bantal	6.3	0.3	250	3.0	−3	100	0.8	—	1650
6SN7WGT	Dual Triode	Military Ruggedized	6SN7GT	Bantal	6.3	0.6	250	9.0	−8	—	—	20	2600
6X4W	Fullwave Rectifier	Military Ruggedized	6X4	7 pin miniature	6.3	0.6	Max. Peak Inv. 1250 Volts Max.			to 70 ma. dc.			
12J5WGT	General Purpose Triode	Military Ruggedized	12J5GT	Bantal	12.6	0.15	250	9	−8	—	—	20	2600
CK5654	Pentode RF Amplifier	Commercial Aircraft Ruggedized	6AK5W	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
CK5670	Dual Triode	Commercial Aircraft Ruggedized	2C51	9 pin miniature	6.3	0.35	150	8.2	Rk 240	—	—	35	5500
CK5686	AF-RF Output Pentode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3	0.35	250	27	−12.5 per sec.	250	5	—	3800*
CK5694	Dual Power Triode	Industrial AF Amplifier	6N7G	Standard glass	6.3	0.8	294	7	−6	—	—	35	3200
CK5725	Pentode RF Mixer	Commercial Aircraft Ruggedized	6AS6W	7 pin miniature	6.3	0.175	180	5.2	−2	120	3.5	—	3800
CK5726	Dual Diode	Commercial Aircraft Ruggedized	6AL5W	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			to 9 ma. dc. per plate			
CK5749†	Pentode RF Amplifier	Commercial Aircraft Ruggedized	6BA6	7 pin miniature	6.3	0.3	250	11.0	Rk 68	100	4.2	—	4400
CK5750†	Pentagrid Converter	Commercial Aircraft Ruggedized	6BE6	7 pin miniature	6.3	0.3	250	2.6	1.5	100	7.5	—	475 Conv. Cond.
CK5751†	Dual High Mu Triode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3‡	0.35	250	1.1	−3	—	—	70	1200
CK5814†	Dual Medium Mu Triode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3‡	0.35	250	10.5	−8.5	—	—	17	2250

†Sample quantities available late in 1950 *2.7 watts Class A output. 10 watts Class C input power to 100 mc. ‡Series heater rating 12.6 volts, 0.175 amps.

Note: All dual section tube ratings are for each section.

RAYTHEON Makes All These Tough Service Tubes — and tens of thousands of them are daily demonstrating their superior reliability and stamina in commercial aircraft, industrial and military service.

These Raytheon tubes are engineered and manufactured specifically for critical services where a single tube failure may lead to serious loss of life or dollars. We are interested in developing additional types for your tough service applications.

Over 300 Raytheon Special Purpose Tube distributors are ready to serve you on the above types. Application information on these tubes is available at Newton, Chicago and Los Angeles.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION · Newton 58, Massachusetts

SUBMINIATURE TUBES · SPECIAL PURPOSE TUBES · MICROWAVE TUBES · CATHODE RAY TUBES · RECEIVING TUBES

SQUARE WAVES

PRECISION GENERATORS by TEKTRONIX

Leading manufacturers now recognize that frequency and transient response measurements are most easily made by square wave testing techniques. This method is widely used on production line testing and adjusting of wideband amplifier, filter and attenuator circuits.

LABORATORY UTILITY

- *FREQUENCY RANGE:*
  25 cps—1 mc, continuously variable.
- *FREQUENCY METER:*
  Direct reading, accurate to 3% of full scale.
- *RISE TIME:*
  .02 μsec. for 93 ohm load.
- *OUTPUT AMPLITUDE:*
  15v across 93 ohm external load.
  160 ma maximum available for external load.
- *SYNC INPUT AND OUTPUT CONNECTIONS.*
- *WEIGHT: 35 lbs.*

TYPE 105
SQUARE WAVE GENERATOR **$395.00**

ASSEMBLY LINE EFFICIENCY

- *FOUR FIXED FREQUENCIES:*
  LF—50 cps, 1 kc.
  HF—100 kc, 1 mc.
- *RISE TIME:*
  LF—3 μsec.
  HF—.02 μsec.
- *OUTPUT AMPLITUDE:*
  LF—0 to 50v, continuously variable in 9 ranges. Accuracy 2% of full scale. Useful as a voltage calibrator.
  HF—0 to 5v.
- *WEIGHT: 21 lbs.*

Both of these instruments feature coaxial outputs, fully regulated DC power supplies, electrically welded aluminum alloy construction and many other characteristics by which Tektronix has become known and accepted throughout the world.

TYPE 104A
SQUARE WAVE GENERATOR
$195.00

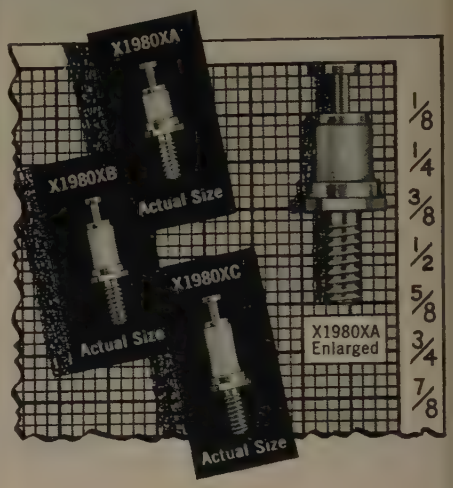
Prices f.o.b. Portland, Oregon.

TEKTRONIX, INC.

712 S.E. Hawthorne Blvd. Portland 14, Ore.

New Miniature Insulated Terminals

to help your miniaturization program



Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eighths of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .141" OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.

custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
456 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

News—New Products

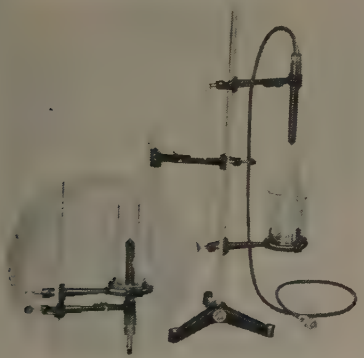
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 56A)

• • • **Cleveland Electronics, Inc.,** 6622 Euclid Ave., Cleveland 3, Ohio, is offering a radio and TV replacement speaker catalog, #127M. Also featured are the new Cletron weather proof speakers and TV lightning arrestors. Write to Bill Allen at Cleveland.

Liquid Nuclear Set

To simplify laboratory work with solutions containing radioactive materials, **Nuclear Instrument and Chemical Corp.,** 229 W. Erie St., Chicago 10, Ill., announces the availability of a special set of equipment which speeds up such counting work.



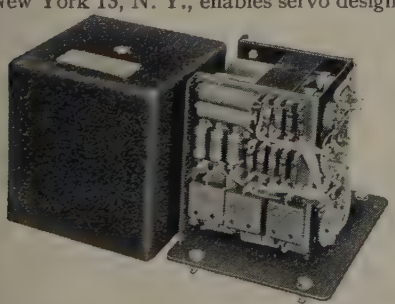
In addition to standard laboratory pieces, such as ring stand and necessary clamps, the set also includes a special Marinelli-type beaker and a support on which the beaker can be mounted. A plug-in type counter is provided with the set over which the Marinelli beaker can be placed.

As part of this set, a test tube of correct size is also provided so that the Geiger tube may be used as a dip counter. For beta counting the test tube is filled with 20 cc of the active liquid which then covers the sensitive area of the counter.

This counter is all glass and is easily decontaminated. The Marinelli beaker may be used only for gamma counting, since a heavy glass wall is interposed between the liquid and the counter. The advantage of this method is that the counter is not contaminated in any way and, therefore, many solutions may be checked without the necessity for cleaning the counter each time.

New Servo Amplifier

A new servo amplifier just developed by the **Transicoil Corp.,** 107 Grand St., New York 13, N. Y., enables servo designers to have a complete servo loop, meeting the requirements of the system under



(Continued on page 60A)

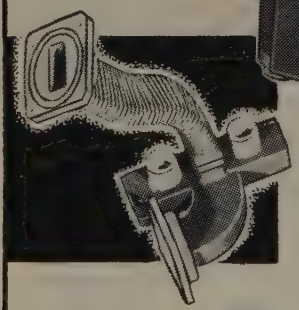
Airtron DESIGNS AND PRODUCES

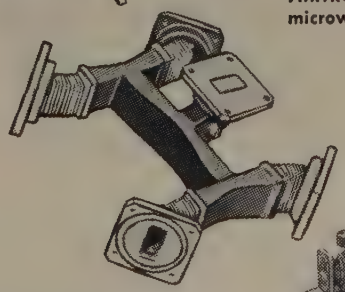
Flexible and *Rigid*

WAVEGUIDE

COMPONENTS

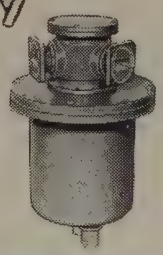
Special Microwave Mixer-Duplexer Assembly Designed by AIRTRON



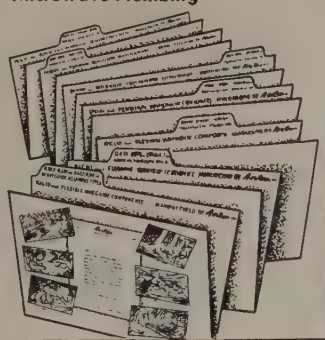


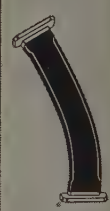
From the smallest waveguide component to complete transmission systems... from the first "doodle" memo or blueprint to the finished precision product . . . make AIRTRON your FIRST source for all types of microwave plumbing. Unique in background, technical savvy, plant facilities and the WILL to SERVE, this organization is prepared to engineer and manufacture your staple or special requirements in:

Mixers
Duplexer Assemblies
Magic Tees
Waveguide Switches
Elbow Bends
Elbow Miters
Twisted Sections
Rigid Twists
Choke Fittings
Flexible Waveguides
Straight Section
Rotary Joints



Send for AIRTRON Engineering Data on Microwave Plumbing



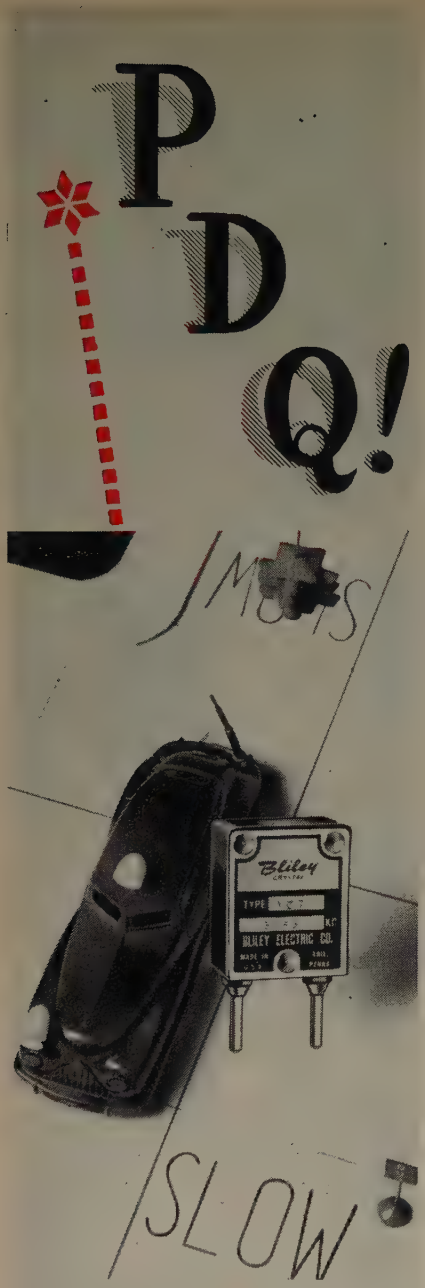


Airtron INC.

105 East Elizabeth Ave., Linden, New Jersey

BRANCH OFFICES

Baltimore Los Angeles New York
Boston St. Louis Dallas Dayton



Shown:
Bliley type MC-7

POLICE
SERVICES DEMAND QUALITY!

Yes, all mobile services demand dependable crystal performance. Bliley engineering skill plus craftsmanship throughout production is quality. Your frequency control will be better with Bliley, the top choice for 20 years.

Bliley
CRYSTALS

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING
ERIE, PENNSYLVANIA

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 59A)

study, in only a fraction of the time previously necessary to build these circuits.

Developed to form a complete package with Transicoil control motors, gear trains, and motor generators, the new servo amplifier is designed to drive a control motor wound for plate-to-plate operation. As such, it operates with a wide variety of ac transmission elements such as autosyns and both resistive and inductive potentiometers. In carrier frequency loops, the amplifier provides all the circuitry needed in the error signal path.

Types available include a laboratory model, and one for production, both made to meet the requirements of the application. A four-page folder providing details is available upon request.

Weatherproof Driver Unit Features Line-Matching Transformer

Specifically designed as an all-purpose driver unit for speech and music, the new Model PM-708TR, just released by **Racon Electric Co., Inc.**, 52 E. 19 St., New York 3, N. Y., features a built-in 25-watt vacuum impregnated line matching transformer. Available impedances: 15, 500, 1,000, 1,500, 2,000 ohms.

In the manufacture of this driver unit only Alnico V magnets and Armco magnetic iron are used. To prevent corrosion, all soft steel parts are doubly plated. An automatic electromagnetic switch employed in the magnetizing process insures maximum flux density in the gap and a high degree of uniformity.

The voice coil is wound with aluminum wire for greatest efficiency and coil terminals are welded instead of soldered. The voice coil lead is a strip of fatigue-resistant beryllium copper to withstand abnormal diaphragm excursion. The voice coil suspension is made of bakelized linen firmly cemented to the phenolic diaphragm with a thermo-setting plastic. Induction heating bakes the diaphragm voice coil suspension and voice coil into an unbreakable bond.

(Continued on page 62A)

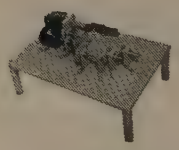
SERVO
PRECISION ELECTRONIC SYSTEMS

SENSING

RADIO DIRECTION FINDING

INSTRUMENTS

SERVOSCOPE



SERVOBOARD

CONTROL

THERMISTOR BOLOMETERS
PRE-AMPLIFIERS
POWER SUPPLIES
SELECTIVE AMPLIFIERS

Write today for complete information

SERVO CORPORATION OF AMERICA
NEW HYDE PARK, N. Y.

You can use a battering ram to make it fit...

BUT it's simpler to design the radio around the battery!

Regardless of what size portable radio you are designing, you'll find compact, long-lasting "Eveready" batteries to fit it. "Eveready" brand batteries give longer playing life. They are the accepted standard for portable radios. Users can get replacements everywhere — they *prefer* portables that use "Eveready" batteries.

CONSULT OUR BATTERY ENGINEERING DEPARTMENT FOR COMPLETE DATA ON "EVEREADY" BATTERIES

● The No. 753 "Eveready" "A-B" battery pack provides plenty of power for compact "pickup" portables. For smaller portables, we recommend "Eveready" No. 950 "A" batteries and the No. 467 "B" battery.

"Eveready", "Mini-Max", "Nine Lives" and the Cat Symbol are trade-marks of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N.Y.

EVEREADY
TRADE-MARK
RADIO BATTERIES

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Specify CP TEF-LINE SUPER TRANSMISSION LINE

A new transmission line based upon a new plastic—TEFLON

CP TEF-LINE transmission line, utilizing DuPont Teflon insulators, greatly reduces high frequency power losses. Furthermore, operation of transmission line at frequencies heretofore impossible owing to excessive power loss now becomes easily possible. For TV, FM and other services utilizing increasingly high frequencies, TEF-LINE by CP is a timely and valuable development worthy of investigation by every user of transmission line.

ONE-PIECE INNER CONDUCTOR
Seal-O-Flange Tef-Line is made of a single piece of copper tubing. Teflon disks are distributed to provide positive, permanent positioning.
COPPER INNER CONDUCTOR OF A TEF-LINE SEAL-O-FLANGE TRANSMISSION LINE SHOWING A ONE-PIECE TEFLON INSULATING DISK FITTING INTO DEPRESSION FORMED IN THE TUBE WALL

CP SUPER TEF-LINE IS AVAILABLE NOW!

Tef-Line can be delivered immediately in three standard sizes—⅞", 1⅝" and 3⅛". With the exception of elbows and gas stops, the new Seal-O-Flange Super Transmission Line is interchangeable with all other CP fittings including end seals, tower hardware, flanges, "O" rings, inner conductor connectors and miscellaneous accessories.

Check your transmission line requirements with the new CP TEF-LINE BULLETIN which is available on request. If you need help in planning installations, our engineers will be happy to talk over specific problems at your convenience.

• TOWER HARDWARE • AUTO-DRYAIRE DEHYDRATORS
• LO-LOSS SWITCHES • COAXIAL DIPOLE ANTENNAS
• SEAL-O-FLANGE TRANSMISSION LINE

Communication Products Company, Inc.
KEYPORT CP NEW JERSEY

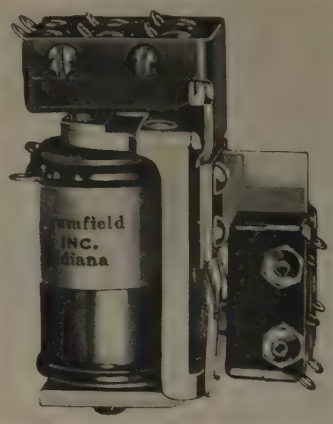
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 60A)

Subminiature Relays

Potter & Brumfield, Princeton, Ind., now offer their subminiature telephone type series MT relays, fitted with from one to four model 1SM1 microswitches. This gives an assembly $1\frac{7}{16}$ inches $\times 1\frac{15}{16}$ inches $\times \frac{11}{16}$ inch with contacts up to 4 form C (4PDT) rated at 5 amperes, 115 v 60 cps resistive load, or 3 amperes at 24 v



dc. Maximum inrush 12 amperes for ½ second. This relay is said to withstand better than 50 G. vibration.

(Continued on page 63A)

NOW!
SPEED UP ALL SOLDERING WITH
UNGAR
FEATHER-LIGHT SOLDERING PENCILS WITH
HI-HEAT
INCREASED WATTAGE
TIPS

For use with No. 776 Handle & Cord Set

Stop wrestling with *big* irons. New HI-HEAT TIPS in your Ungar Electric Soldering Pencil produce a really versatile tool that'll perform on a par with the big, bulky 100-150 watt irons. If you can't get immediate delivery, please be patient, for production hasn't yet caught up with demand. Ask your supplier for No. 1236 Pyramid or No. 1239 Chisel. List price, $1.25 each.

Ungar
ELECTRIC TOOL CO., Inc.
LOS ANGELES 54, CALIFORNIA

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 62A)

The 1SM1 microswitch is molded bakelite enclosed, thus protecting the contacts and springs from most environment conditions. Extremely compact size and high vibration resistance make this assembly particularly applicable to rocket, missile and aircraft installations. The relay may be used unhoused or hermetically sealed in the model "M" deep drawn steel can 1 inch $\times 1\frac{11}{16}$ inches $\times 2\frac{5}{32}$ inches high. The hermetically sealed assembly can be fitted with either plug-in or solder terminals, with high dielectric glass insulation. Actuating coils for either ac or dc are available.

The microswitches are so mounted that the differential lever action of the armature permits lower coil power and fast positive operation.

(Continued on page 66A)

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

Centralab

ERL

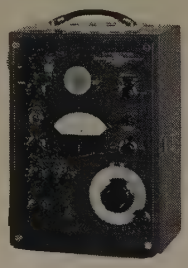
Division of GLOBE-UNION INC.
Milwaukee

The First Name in Ceramic Electronic Components

TIC INSTRUMENTS THAT BELONG IN *Your* LABORATORY

Type 310-A Z-Angle Meter — 30 to 20,000 c.p.s.

Measures impedance directly in polar coordinates as an *impedance* magnitude in ohms and *phase angle* in degrees $Z \angle \pm \ominus$. Measures, with equal ease, pure resistance, inductance, capacitance or complex impedances comprised of most any RLC combinations. Range: Impedance (Z), 0.5 to 100,000 ohms; Phase Angle ($\ominus$), $+90°$ (X_L) through $0°$ (R) to $-90°$ (X_C). Accuracy: Within $\pm$ 1% for impedance and $\pm$ 2° for phase angle. Price: $425.00.

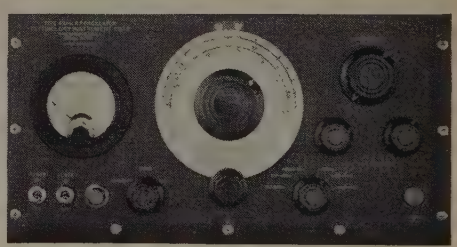


Type 311-A R-F Z-Angle Meter for radio frequencies — 100 kc to 2 mc.

Simplifies laboratory and field *impedance* and *phase angle* measurements. Ideal for checking impedance of coils, transformers, coupling networks, lines, filters, antennas, etc. Direct-reading Impedance Range: 10 to 5,000 ohms up to 200 kc, and 10 to 1,000 ohms at 1 mc. Phase Angle: $+90°$ (X_L) through $0°$ (R) to $-90°$ (X_C). Accuracy: Impedance to within $\pm$ 3%, and phase angle $\pm$ 4°. Price: $350.00.

Type 410-A R-F Oscillator — 100 kc to 10 mc. (Special models 46.5 kc to 4.65 mc available.)

Power oscillator for use as bridge driver and general laboratory measurements. Features: High stability, high output (approximate 30 volts), 50-60 Ω output impedance, expanded frequency scale, direct reading output voltmeter, compact design. Price: $350.00.



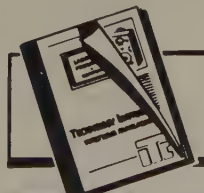
Type 320-A Phase Meter — frequency range 20 cycles to 100 kc.

The *first* commercially available all-electronic instrument that directly measures the phase angle between two voltages *in a simple* operation. Ideally suited to applications in such fields as audio facilities, ultrasonics, servomechanisms, geophysics, vibrations, acoustics and many others.

Phase angle readings made directly without balancing . . . stable at frequencies as low as 2 to 3 cycles. Voltage range: 1 to 170 peak volts. Terminals for recorder . . . choice of relay-rack or cabinet mounting. Price $475.00. Cabinet $20.00.

Type 110 Slide-Wire Resistance Box

Convenient combination consisting of precision decade resistor and continuously adjustable slide-wire which provides smooth, continuous variation of resistance between decade steps (permits adjustment of resistance to one part in 10,000). For most applications, eliminates need for more elaborate multi-dial decade boxes. Ideal for student and general laboratory use. Decade resistance cards adjusted to within $\pm$ 0.1% of nominal values, and slide-wire resistors direct-reading to within 1% of their maximum values. Cast aluminum cabinet. All resistance elements completely enclosed. Suitable for use at audio and ultrasonic frequencies. Type 110-A, range 0-11,000 ohms: $42.50. Type 110-B, range 0-110,000 ohms: $45.00.



Technical catalog—yours for the asking. Contains detailed information on all TIC Instruments, Potentiometers and other equipment. Get your copy without obligation—write today.

TECHNOLOGY INSTRUMENT CORP.

1058 Main Street, Waltham 54, Massachusetts

Engineering Representatives *Cleveland, Ohio PRospect 6171*

Chicago, Ill.-UPtown 8-1141 Boonton, N.J.-Boonton 8-3097 Rochester, N.Y.-Genesee 3547M
Cambridge, Mass.-ELiot 4-1751 Canaan, Conn.-Canaan 649 Hollywood, Cal.-HOllywood 9-6305
Manhasset, N.Y.-Manhasset 7-3424 Dayton, Ohio-Michigan 8721

MICROWAVE TEST EQUIPMENT

PULSE EQUIPMENT

G.E.K.—2745 ..... $39.50
G.E.K.—2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS $39.50
W.E. 3D166173 Hi-Volt input transformer. W.E. impedance ratio 50 ohms to 900 ohms, Freq. range; 10 kc to 2 mc. 2 sections parallel connected, potted in oil $36.00
W.E. KS 9800 input transformer, Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. K2450A. Will receive 13 KV.4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E. $34.50
TPS10 Modulator X Band $350.00
SO-4 Radio Thyratron $425.00
SCR-268 Keyer units $95.00
715B Tubes $12.00
705A Tubes $2.80
705 Sockets ..... $.70
Complete line of high voltage pulse transformers, networks and dual lines.

23,000 TO 27,000 MC. BENCH TEST PLUMBING
½" x ¼" WAVEGUIDE

PRECISION SLOTTED LINE. DeMornay Budd type 337, complete with adjustable probe and crystal output. Square flanges. $400.00
PRECISION SLOTTED LINE. Adjustable probe. Humble Oil type. CPK-21HU $200.00
DIRECTIONAL COUPLER-WAVEMETER MOUNT. 12DB $60.00
PRECISION VARIABLE ATTENUATOR. mfg. Bernard Rice $90.00
TUNABLE CRYSTAL MOUNT. DB423 less tuning plunger $30.00
FLAP ATTENUATOR. DB405 10DB attenuation $25.00
LOW POWER LOAD $25.00
SCREW TUNER $25.00
SHUNT TEE $35.00
WAVEGUIDE LENGTHS. 2" to 6" long, gold-plated with circular flanges and coupling nuts ..... $2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS32 ..... $49.50
Mitered Elbow, cover to cover $4.00
TR-ATR Section, choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adaptor, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" ..... $1.00 per ft.
Circular Flanges ..... $.50
Flange Coupling Nuts ..... $.50
Slotted line, DeMornay Budd #397, new $450.00
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB ..... $49.50 ea.
K BAND 2K33 w/cav $115.00
3J31 Magnetrons $55.00

ARMY-NAVY TEST SETS

TS-226A/AP Power Meter.
TS62/AP 3 centimeter precision echo box.
TS36/AP 3 centimeter Thermistor Bridge—Power Meter.
TS89/AP Voltage divider.
TS268/U Crystal checker for IN23 type crystals etc.
CW-60ABM 10 Centimeter Wavemeter. Coaxial type micrometer adjust cavity. Resonance indicating meter, carrying case (similar to TS117/GP)
TS235/UP High Power Load, "L" band (1000 mcs.)
LU-1 Freq. Meter and Test OSC. Type CRV-60ACL
TVN-9HU Power Supply. M.I.T. Rad. Lab.
TVN-8SE Klystron Power Supply. M.I.T. Rad. Lab.
CS60ABW Watt Meter—Wavemeter. 3 centimeter.
APR5 Receiver—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC input.

TEST EQUIPMENT

Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line New $425.00
SO-3 Receiver, 30 mc. IF. 6 stages 6AC7. 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc in ch. 13 vol. 23 M.I.T. Rad. Lab. Series $99.50
APS-2 10 CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser, 714 magnetron 417A Mixer all ⅞" rigid coax, incl. revr. front end $210.00
10 cm. cavity type wavemeters 6" deep, 6½" in diameter Coax. Output Silver Plated ... $84.50 ea.
10 cm. echo box. Part of SFI Radar W/115 volt DC Tuning motor Sub Sig. 1118AO $47.50

8500 Mc. to 9600 Mc. Bench Test Plumbing
1" x 1½" WAVEGUIDE

SLOTTED LINE. Complete with adjustable probe, crystal output, precision vernier adjust. Humble oil type $220.00
KLYSTRON MOUNTS. DeMornay Budd type DB380 for 2K25 etc. includes tunable termination $70.00
VARIABLE ATTENUATOR. DeMornay Budd type DB383. Maximum attenuation 35DB. $120.00
VARIABLE STUB TUNER. DB536. 180 degree phase shifting capability $70.00
FLAP ATTENUATOR. DB385. Maximum Attenuation 10DB $25.00
MAGIC TEE. DB539. ..... $42.00
WAVE GUIDE TO TYPE "N" ADAPTOR. DB377 ..... $15.00
LOW POWER TERMINATION. DB381 ..... $18.50
UNI-DIRECTIONAL COUPLER. DB390. 23DB type "N" output $18.50
PICK UP HORN. Type "N" output $4.50
WAVEMETER. 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type ..$85.00
WAVEGUIDE LENGTHS. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections ..... $2.00 per ft.
90 DEGREE ELBOWS. E or H plane, 2½" radius $12.50
MITERED ELBOWS. E or H plane $10.00
45 DEGREE OFFSET ELBOWS. E or H plane $10.00
90 DEGREE TWIST. 6" long $8.00
BULKHEAD FEED—THRU ASSEMBLY ..$15.00
PRESSURE GAUGE SECTION. 151b. gauge and press. nipple $10.00
PRESSURE GAUGE. 15 lbs. $2.50
CRYSTAL MOUNT. 1N23 type crystal holder $17.50
DUAL OSCILLATOR-BEACON MOUNT. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields $42.50
DUAL OSCILLATOR MOUNTS. (Back to back) with crystal mount, tunable termination, attenuating slugs $18.50
KLYSTRONS 723AB $12.00
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Broad Band Directional coupler, type "N" take off choke to cover, 23 DB calibrated $18.50
Flexible Section 18" long $12.00
Rotary Joint Choke to Choke $10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50
723AB Mixer-Beacon Dual Oscillator Mount Matching slugs and tunable termination, new ..$24.50

1¼" x ⅝" WAVEGUIDE

SLOTTED LINE. Complete with adjustable probe, crystal output, precision vernier adjust. Humble Oil type $225.00
TUNABLE TERMINATION. Precision adjust. $65.00
LOW POWER TERMINATION $25.00
MAGIC TEE $45.00
TRANSITION. 1¼" x ⅝" to 1" x ½" ...$19.50
OSCILLATOR MOUNT. for four 723AB klystron $38.50
90 DEGREE ELBOWS. E or H plane $12.50
WAVEGUIDE LENGTHS. Cut to size and supplied with 1 choke, 1 cover. per length ..$2.00 per ft.
WAVEMETER: Absorbtion type. Precision micrometer adjust. Very high Q $150.00

MAGNETRONS

2J27	
2J31	2J62
2J21-A	3J31
2J22	5J30
2J26	714AY
2J32	718DY
2J37	720BY
2J38	720CY
2J39	725-A
2J40	730-A
2J49	728
2J34	700
2J61	706

KLYSTRONS

723A 2K42
707B W/Cavity
417A 2K22
2K41 726B
2K26 2K55 726C

"CW" MAGNETRONS

QK 62 3150-3375 mc.
QK 59 2675-2900 mc.
QK 61 2975-3200 mc.
QK 60 2800-3025 mc.
QK 915

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$ 8.90
5200	21/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons ..... $24.50 ea.
GE Magnets type M7765115, GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1⅝". New Part of SCR 584 ..... $34.50

THERMISTORS

D-167332 (tube) ..$.95
D-170396 (bead) ..$.95
D-167613 (button).$.95
D-164699 for MTG in "X" band Guide $2.50
D-167018 (tube) ..$.95
D-168687 ..... $.95
D-171812 ..... $.95
D-171528 ..... $.95
D-168548 ..... $.95
D-168442 ..... $3.00
D-165593 ..... $1.25
D-98836 ..... $2.00
D-161871A $2.85
D-171121 ..... $.95

VARISTORS

D-170225 ..... $1.25
D-167176 ..... $.95
D-162356(308A) .$1.50
D-163357 ..... $2.00
D-99946 ..... $2.95

6000 Mc. to 8500 Mc. Bench Test Plumbing

1½" x ¾" WAVEGUIDE
KLYSTRON MOUNT. DB356 complete with shield and tunable termination $125.00
FLAP ATTENUATOR. DB361 ..... $45.00
PRECISION WAVEMETER. DB358. Micrometer adjust head $190.00
VARIABLE STUB TUNER. $90.00
WAVEGUIDE TO TYPE "N" ADAPTER ..$18.50
WAVEMETER TEE. DB352 ..... $32.50
SLOTTED LINE. DB354 Precision vernier adjust, less probe $320.00
MAGIC TEE $80.00
DIRECTIONAL COUPLER. Two hole 25DB coupling, type "N" output $25.00
PRECISION CRYSTAL MOUNT. Equipped with tuning slugs and tunable termination ..$125.00
TUNABLE TERMINATION. Precision adjust $70.00
LOW POWER LOAD $35.00

4000 to 6000 mcs. Bench Test Plumbing
2" x 1" WAVEGUIDE

SLOTTED LINE. DeMornay type 332 complete with probe, etc. $600.00
FLAP ATTENUATOR $48.00
VARIABLE STUB TUNER AND LOW POWER TERMINATION $48.00
WAVEMETER TEE $48.00
ADAPTERS: Choke to choke $18.00
Cover to cover $14.00
Choke to cover $16.00
WAVEGUIDE TO TYPE "N" ADAPTER ..$45.00
DIRECTIONAL COUPLER. Two hole type, type "N" output $48.00
KLYSTRON MOUNT. Equipped with tunable termination and micrometer adjust. klystron antenna tuning $110.00
CRYSTAL MOUNT. Equipped with tunable termination and micrometer adjust crystal tuning $125.00
TUNABLE TERMINATION. Precision adjust $90.00

3000 MC BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type. Type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

R. F. EQUIPMENT

LHTR. LIGHTHOUSE ASSEMBLY. Part of RT-39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice .$47.50 ea.

S. BAND

90° Twist, circular cover to circular cover....$25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount, Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOORNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees ..... $75.00 per set
POWER SPLITTER: 726 Klystron input dual "N" output $5.00
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated ....$2.00 ea.

⅞" RIGID COAX

Magnetron Coupling with TR Loop, gold-plated $7.50
Sperry Rotating Bend, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length $7.50
Short Right Angle Bends (for above) $2.50

GENERAL TEST EQUIPMENT

Multi Frequency Generator. American Time Product type SC-16. Frequency 10 to 190. Precision Standard "Watch-Master"
UHF Signal Generator R.C.A. type 710A 370 to 560 mcs.
Wheatstone Bridge. Industrial Instruments type RN-1
FM Signal Generator. Boonton Radio type 155A Freq. range 1 to 10 mcs., 38 to 50 mcs.
Condenser Weld Power. Cap. 56 mfd. max., max. chg. 1500 Volts
Frequency Meter. Lavoie Model 105-300 to 600 mcs.
Megohm Bridge. Industrial Instruments type MB.
Visual Alignment Signal Generator. General Electric—0 to 60 mcs.

NEW TEST EQUIPMENT IN STOCK

1-185A Oscillator — WRITE
1-158 Range Calibrator — WRITE
1-223 Range Calibrator — WRITE
BC 438 Freq. Meter — PHONE
RF Preamp. — FOR
G.R. Capacity Brdg. #216 — DATA
G.R. Uni Galvo Shunt #229 — AND
G.R. 100 SL Aud. Osc. #213 — PRICE
TS226A/AP Pwr. Mtr. 0-1000 W.
Sig. Gen. 2304 8-330 MC
183J Dynamotor Test set

All merch. guar. Mail orders promptly filled. All prices, F.O.B., N.Y.C. Send Money Order or Check. Only shipping charges sent C.O.D. Rated Concerns send P.O.

COMMUNICATIONS EQUIPMENT COMPANY

131 LIBERTY STREET, NEW YORK, N.Y. DEPT. 19 P. J. PLISHNER PHONE DIGBY—9-4124

QCQ2 SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use: Medium ASW ships.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards, and manual.
Projector. Magnetostrictive, permanent magnet polarization, resonant frequency about 25 kc.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located the output tubes and the high voltage rectifier. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned-radio-frequency type. It includes time varied gain, to reduce the volume of reverbrations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note above or below 800 cycles.
Keying and indicating system. Keying is mechanical; cams in the indicator unit determine the pulse length and keying interval. Ranges are indicated by the flash of a neon lamp.
Complete sets available less hoist. Also stacks alone.

QBF and QJA SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use. Large ASW ships.
ABF may be converted by field modifications, to QJA available.
Keying interval. 1,000, 2,000, 3,000, 4,000, 5,000 10,000 yards and manual.
The electrical train system consists of a handwheel on the stack which selects, by commutation, three voltages from the secondary of a transformer-like device called a Commutator Transmitter.
Projector. The projector is of the Rochelle salt crystal type with a single element used for both listening and ranging. The frequency is 22 to 28 kc.
Transmitting system. The receiver-driver oscillator unit contains two electron tube oscillators, one fixed at about 150 kc and one tunable over the range from 160 to 180 kc. The outputs of the two are mixed, producing a difference frequency, which is then fed to the driver-amplifier unit and thus to the projector.
Receiving system. The receiver is a superheterodyne type covering the range from 10 to 30 kc.
Keying and indicating system. Ranges are indicated by the flash of a neon lamp which revolves at a constant speed, driven by a synchronous motor.

QCU, QCU-1 SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use. Small ASW Ships.
Intended to be used as a replacement for the obsolete WEA-1 equipment the old hoist.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards and manual.
Training is electrical, controlled by a hand crank at the remote station.
Projector. Magnetostrictive, permanent magnet polarization, resonant frequency about 25 kc, split for BDI.
Transmitting system. The electron tuoe driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located two type 811 output tubes and two type 836 high voltage rectifier tubes. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned radio frequency type. It includes time varied gain, to reduce the volume of reverberations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note, above or below 800 cycles.

QCS, QCS-1, QCT-1 SONAR

ECHO RANGING AND LISTENING EQUIPMENT

Use. ASW ships.
Keying interval (original)—1,000, 2,000, 5,000, 10,000 yards and manual. (field modification added 3,000 and 4,000 yards)
Transmitting system. The driver-rectifier unit contains an electron-tube oscillator tunable over the range of 17 to 25.5 kc, and electron-tube amplifier and a rectifier power supply.
Receiving system. The superheterodyne receiver covers the range from 13 to 37 kc and may be connected by a selector switch to either the "QCQ" or the "JK" face of the projector. It has separate audio amplifiers for the range indicator lamp and for the loudspeaker. The audible note may be adjusted over the range from 0 to 1600 cycles. Three degrees of i-f selectivity and two of audio are provided by selector switches connected to filters.
Keying and indicating system. Keying is mechanical; cams driven by the range indicator disc shaft determine the pulse strength and keying interval.

Complete 3 CM Radar System Equipment
40 KW peak transmitter, pulse modulator, receiver, using 723AB, power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, all tubes, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

High Voltage Power Supply
15 KV at 30 Ma DC, Bridge Rectifier, Western Electric ..$125.00

RADIO SYSTEMS

TAJ 500 Watt Low Frequency Transmitter 150-550KC CW-MCW.
TBK 500 Watt High Frequency Transmitter 2-18 MC. A1, A2, A3, Emission Mfg. by RCA.
White Radio Telephone Model #WRMSS—ship to ship—ship to shore—small airports—mines—plantations—inter island—ranches. 10 channel fix tuned rec. & xmitter. Xmittr. pwr. output in excess of 100W unmodulated into antenna of 18Ω & 100 MMF. Freq. Range 2-12 MC. Can be modified to increase range. Xtal controlled. 110V 60 cy or 220V 60 or 25 cy. Meas. 24" H x 19" WX 14" D. 125 lbs. Write or phone for data.

FM STATION

Kilowatt Amplifier
Model 4BT2A1 Type BT2A Serial RC25
250 Watt Exciter
Model 4BT1A1 Type 3T1A Serial CC833
Station Monitor
Model 4BM1A1 Type BM1A Serial WC268
Power Supply
Model BP241 Type BF2A Serial WC547
Transmitter Console
Model 4BC3A1 Type BC3A Serial WC5
Type BX-2A Two Bay Circular Antenna with Mast, Transmission Line, Elevators and Matchers.
100 Feet of 1⅝ coax, transmission line including 90° elbows.
Dehydrator for transmission line.
Desk and Chair for transmitter console.

Write or Phone for Data and Price

RADAR

APS-2 10 cm. airborne radar set designed for navigation and high altitude bombing. The antenna rotates through 360 degrees. Presentation is PPI and A Scope. The following units of the set are supplied: Antenna, transmitter-receiver, modulator, indicator, 24VDC input power unit. New with all tubes, incl. 714AY magnetron, 417A klystron.

APS-3 3 cm. airborne radar set designed for intercept of enemy aircraft and nominal navigation. Antenna is sector scan. Remote as well as master indicator is supplied. 725A magnetron operates the set at 45kw. Complete sets available with all tubes incl. magnetron and 723AB klystrons. Both new and used condition.

APS-4 cm. airborne radar set designed for sector scan surface search, mapping and navigation, weather forecasting intercept of enemy aircraft. Entirely enclosed in a streamlined housing for optional mounting on aircraft bomb rack, or on nose of large bombers. Complete sets with indicator equipment, and power unit ready for installation.

APS-6 3 cm. Night Fighter radar with pencil beam antenna. Transmitter-receiver packages and antennas available in equal to new condition.

APS-6A 3 cm. airborne radar RF package, 45kw, using 725A magnetron, IF strip using 6AK5's, 723AB beacon and local oscillator.

APS-10 3 cm. airborne radar using 2J42 magnetron. Modulator decks and low voltage power supply, only, available, less tubes. Beacon—local oscillator klystron mounts are available.

APQ-13 3 cm. airborne radar complete RF package in excellent condition including all tubes.

APS-15 3 cm. airborne radar designed for high altitude bombing, navigation, intercept of enemy aircraft, weather forecasting. Antenna rotates 360 degrees. Presentation is PPI and A Scope. The following units are supplied: Antenna, transmitter-receiver, modulator, indicator, slant-range computer, 24VDC input power unit. New with all tubes including 45kw 725A magnetron. 723AB local oscillator-beacon.

CPN-8 10 cm Navigation Beacon ground station. Complete and partial installations available. High power beacon of long range capability. Complete power, frequency, operation analyzer (5" scope) included.

CXBR 10 cm. M.I.T. navigation beacon equipment, complete, in excellent condition.

FD MARK IV 800 mc. gunlaying radar mfg. and designed by Western Electric for battleships. Complete consoles available with all tubes including 700A magnetron and modulator thyratron.

MARK 10 10 cm. gunlaying radar, complete, for automatic firing of guns as antenna tracks target. 250 KW.

SA 200 cm. Air Search radar especially designed for shipboard of mobile installation. Ideal for ground intercept and control of aircraft. PPI 7" indicator. Long range.

SD 200 cm. radar similar to SA but designed for installation on submarines. New.

SE 10 cm. shipboard Surface Search radar, using thyratron modulator. Complete installation available including spare parts. "A" scope presentation. 250 KW.

SF-1 10 cm. shipboard Surface Search radar with PPI and A scope. Used for navigation and target range information on naval vessels. 250 KW.

SG 10 cm. shipboard Surface Search radar with PPI and A scope. Heavy, rugged equipment designed for large naval and merchant vessels. 250 KW.

SJ-1 10 cm. radar designed for installation of Submarines. Equipped with PPI and A scope. Complete installations.

SL 10 cm. radar designed for Surface Search on shipboard. PPI indicator console.

SN 10 cm. portable radar. Lightweight, easily transportable complete radar installation using lighthouse tubes with a 25 mile maximum range. 115 V AC operation.

SO-1 10 cm. shipboard radar for navigation of all types of vessels. 4, 20, and 80 miles range. PPI indicator. Large antenna. 115 V DC input.

SO-8 Same as SO-1 but with a lightweight antenna.

SO-13 Same as SO-1 but with a lightweight antenna, 28 V DC input. Designed for PT boat installation.

SCR-518 Radar altimeter using pulse-echo-time principle, 400 mc, 28 V DC input, CR tube altitude indication.

SCR-520 Airborne radar RF package, 10 cm., complete with pulser, 714AY magnetron.

SCR-533 IFF/Air Search trailer, complete, 500mc operation, A scope.

SCR-663 Sperry searchlight training, aircraft tracking ground installation. Used condition.

TPS-2 1000 mc. portable early warning system. Bed spring antenna. Complete with portable gasoline generator.

UPN-2 10 cm. portable beacon equipment.

SQ 10 cm. portable radar designed for use on landing barges and beach heads. PPI, B. A indication on 3" scope. 115V AC operation.

MORE TEST EQUIPMENT Phone or write for information
TS 36, 110AP, 35, 62, 108, 102, 111, 34, 104, 45, 102, 33, 107, 16

SONAR

COMMUNICATIONS EQUIPMENT CO.
131 Liberty Street, New York, N.Y.
Dept. 19 **P. J. Plishner** **Phone Digby—9-4124**

TWO *NEW* *TWIN* POWER SUPPLIES

MODEL 610-F

- Precise Electronic Regulation.
- 2 Independent Sources of Power.
- 0-325 V.D.C. at 0-100 Milliamperes. Continuously Adjustable.
- 0-325 V.D.C. at 0-200 Mils of the Sources are Combined.
- Both D.C. Outputs Metered for Voltage or Current.
- A.C. Ripple Less than 10 Millivolts.

MODEL 1210

- Precise Electronic Regulation.
- 2 Independent Sources of Power.
- 0-500 V.D.C. at 0-150 Milliamperes. Continuously Adjustable.
- 0-500 V.D.C. at 0-300 Mils if the 2 Sources are Combined.
- Both D.C. Outputs Metered for Voltage or Current.
- 6.3 or 12.6 V.A.C. Outputs Provided.
- A.C. Ripple Less Than 10 Millivolts.

Also available with regulated bias output.

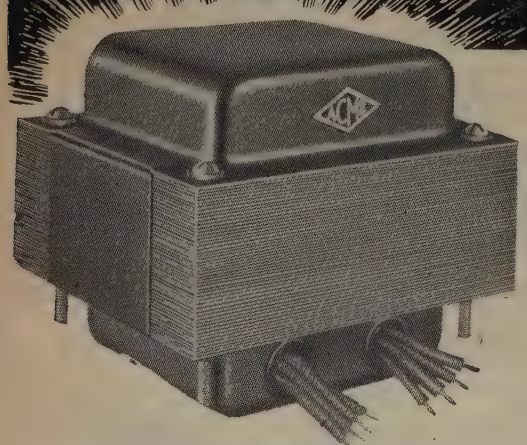
Furst *Twin* Power Supplies double the usefulness of a single unit at considerable saving in space and cost. Write for complete specifications on these and other Furst *Twin* Power Supply Models.

FURST ELECTRONICS

10 S. Jefferson St., Chicago 6, Ill.

FOR BETTER *PERFORMANCE* BETTER BUY

Acme ACME Electric TRANSFORMERS



You write the specifications and Acme engineers will design a transformer with the exact output characteristics to provide "top" performance for your product. And remember, in addition to quality performance, Acme also can provide quantity production in custom designed electronic transformers.

ACME ELECTRIC CORPORATION • 449 Water St., Cuba, N.Y., U.S.A.

Acme ACME Electric TRANSFORMERS

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 63A)

Variable Electronic Filter

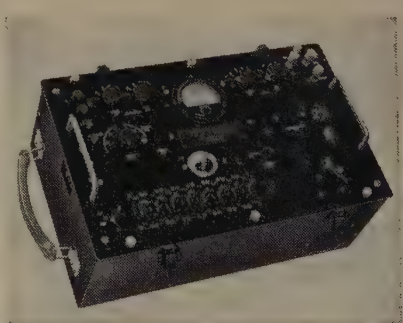
Spencer-Kennedy Laboratories, Inc., Dept. IR, 186 Massachusetts Ave., Cambridge 39, Mass., has a new Model 300 variable electronic filter. Due to a new and patented circuit, it has the unusual specification of a continuously variable cutoff within the frequency range of 20 cps to 200 kc. With an attenuation rate of 18 db per octave, it is analogous in performance characteristics to the Constant-K inductance capacitance filter.

A range switch selects the type of section desired, high-pass or low-pass, as well as four-decade frequency ranges. Several filters can be cascaded so that attenuation rates of 36-, 54-, etc. db per octave can be realized. Sections can be combined to make a variable band-pass filter.

Ligh in weight, compact in construction, and including a regulated power supply, the Model 300 variable electronic filter has many uses in the movie, radio broadcasting, television, and sound recording industries.

Multipurpose Transmission Test Set

In addition to measuring the electrical characteristics of telephone lines and equipment the new multipurpose transmission test set developed by **Shallcross Manufacturing Co.,** 520 Pusey Ave., Collingdale, Pa., may be used for efficiency tests on local and common battery telephone



(Continued on page 67A)

News—New Products

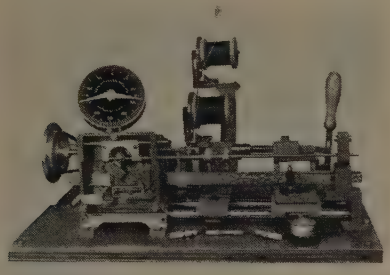
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 66A)

lines and sets, carbon microphones, receivers, and magnetic microphones, and to test capacitors, generators, ringers, insulation resistance, dials, and continuity. Key switches and dials are used to select and control the test circuits. The 693 Transmission Test Set is powered by external batteries. It features compact, substantial construction and is fully portable.

Improved Coil Winding Machine

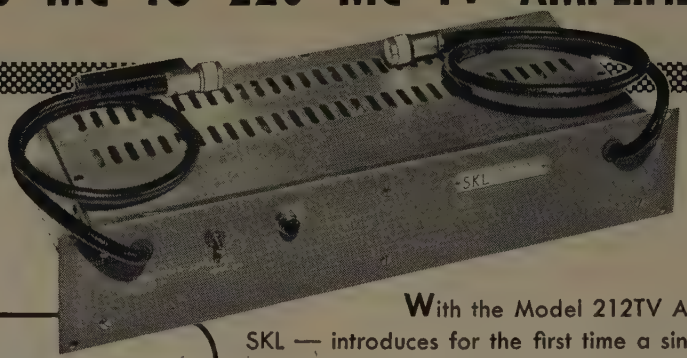
An improved coil winding machine, Model 125, that winds coils and solenoids up to 8 inches in length instead of 6 inches,



has just been announced by **George Stevens Mfg. Co., Inc.**, 6022 N. Rogers Ave., Chicago 30, Ill.

(Continued on page 68A)

40 MC TO 220 MC TV AMPLIFIERS



SPECIFICATIONS

- **BANDWIDTH** 40 MC — 220 MC
- **IMPEDANCE** 52, 72, and 93 ohm unbalanced, 300 ohm balanced
- **GAIN** . . . . . 20 db
- **OUTPUT VOLTAGE** 4 volts RMS Maximum
- **RESPONSE** ± 2 db over bandwidth
- **PRICE** $200.00 f.o.b. Cambridge, Mass.

With the Model 212TV Amplifier—SKL — introduces for the first time a single broad band booster capable of amplifying all 13 television channels simultaneously. Because of its stability and reliability — a tube failure means only a slight loss of gain, not amplifier failure — the Model 212TV Amplifier can be safely left unattended for long periods of time. Its low noise level, high output, and low impedance make the Model 212TV Amplifier ideal for television distribution systems in hotels, apartment houses, sales rooms and television stations and manufacturers' plants.

Write today for further information

SKL SPENCER KENNEDY LABORATORIES, INC.
186 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

HIGHEST QUALITY ELECTRONIC COMPONENTS

Large Quantities in Stock for Immediate Delivery

RELAYS — TUBES
TRANSFORMERS — CHOKES
VOLUME CONTROLS — RECTIFIERS
WIRE & CABLE — TUBE SOCKETS
RESISTORS (WIRE WOUND, CARBON, etc.)
CONDENSERS (MOLDED, CERAMIC, OIL FILLED, etc.)
SWITCHES (TOGGLE, MINIATURE, WAFER, etc.)

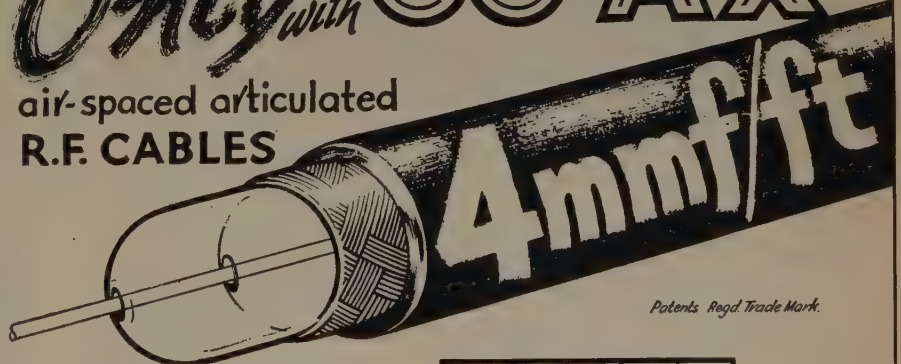
All standard brands, inspected and guaranteed by Wells Sales.

Manufacturers: Write for complete Electronic Catalog and prices.
Dept. P

WELLS SALES, INC.
320 N. LA SALLE ST.
CHICAGO 10, ILL.

Only with CO-AX

air-spaced articulated
R.F. CABLES



Patents Regd. Trade Mark.

THE LOWEST EVER CAPACITANCE OR ATTENUATION

We are specially organised to give
SPOT DELIVERIES TO U.S.A
Cable your rush order for shipment by air freight.
Settlement by your own $ check

LOW ATTEN TYPES	IMPED OHMS	ATTEN db100ft at 100 Mc/s.	LOADING Kw	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	
A 34	73	0.6	1.5	0.88	HIGH POWER FLEXIBLE
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	V.L.C. ★
C44	4.1	252	2.1	1.03	

★ *Very Low Capacitance cable.*

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD LONDON SW7 ENGLAND
CABLES. TRANSRAD. LONDON.

COSSOR for QUALITY

WHEN TIMING COUNTS....

you can count on

Cossor Twin Beam Scopes

UNIQUE twin beam flat face tube permits EXACT time comparison of two waveforms without phase or frequency error. Beams are independent vertically and locked in horizontal direction, can be separated, superimposed or crossed for any comparative test . . . and . . .

Model 1035 TWIN BEAM SCOPE (illustrated) offers these additional features:

DIRECT time measurement on calibrated controls from 150 millisec. to 1 microsec. DIRECT voltage measurement on each beam from 500 volts to 1 millivolt.

Recurrent or triggered sweeps from 150 millisec. to 5 microsec. High gain, wideband amplifier, —3 db. at 7 Mc.

Write for details on Model 1428 Scope Camera for still or moving film records.

All instruments and spares in stock New York.

$465 fob Halifax
$650 fob New York

COSSOR (CANADA) LIMITED
301-303 Windsor Street, Halifax, N.S.
BEAM INSTRUMENTS CORPORATION
Room 907, 511 5th Avenue, New York 17, N.Y.

E-I HERMETIC SEALING COMPONENTS

ENGINEERS, DESIGNERS, PURCHASING AGENTS! SAVE TIME AND EFFORT

with the E-I SAMPLE KIT!

New designers kit contains 81 standard terminals and 11 different headers. These mass produced, economy-priced standard parts solve practically all problems requiring hermetic sealing. Transparent case with labeled bins makes it easy to select the correct component for your needs. The E-I SAMPLE KIT is available at the nominal price of $10.00. Send check with order or request the free E-I illustrated brochure today!

Write for these descriptive bulletins:
849 — Hermetically Sealed Terminals
850 — Hermetically Sealed Multiple Headers
851 — Gasket Type Bushings

E-I INC ELECTRICAL INDUSTRIES
INCORPORATED
44 SUMMER AVENUE • NEWARK 4, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 67A)

The new model is mounted on rods instead of a cast iron base. The rods make possible better alignment and more flexibility because the tailstock now can be moved back and forth as well as from side to side. Also, the tension bracket may now be moved to any position to suit the winding arbor.

The new model's tailstock handle is now vertical, permitting it to be moved by the operator's elbow and leaving the operator's hand free. The vertical tailstock handle can also be easily adapted to a foot pedal. Bushings for the cam follow rod are hardened and ground, instead of oilite.

Cam, gears, and idler forming the pattern are now enclosed in front by a clear plastic window, keeping them in plain sight of the operator at all times. The traverse rack is driven by change gears and idler enclosed in back of the head. The traverse rack has an adjustable stop to insure return to identical starting position.

Model 125 also winds progressive universal coils up to 4 inches in length and 3 inches in diameter, universal coils up to $\frac{3}{4}$ inch in width, and lf coils. The Model 125 winds wire from 20 to 44 gauge. Cams are stocked from $\frac{3}{4}$ inch to $\frac{1}{16}$ inch in decrements of $\frac{1}{64}$ inch. Sizes larger than $\frac{3}{4}$ inch or less than $\frac{1}{64}$ inch are made upon special order.

(Continued on page 70A)

ALLISON RADAR

FOR

MULTI-ENGINED AIRCRAFT

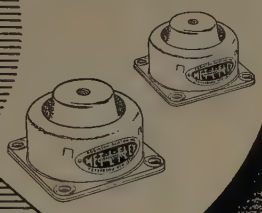
Military • Airline • Executive

MODELS E ES ESB
58-65 LBS. OVERALL WEIGHT

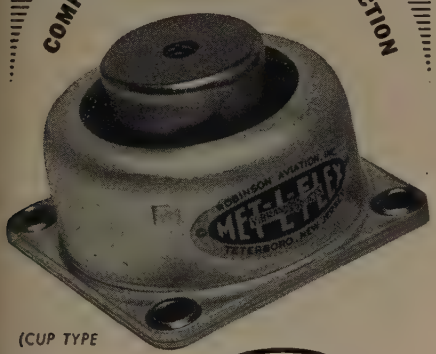
1. Long range. 80-150 miles.
2. Exclusive scanning method.
3. Compact. Sturdy.
4. Easy to operate. Pilot control.
5. Simplicity of maintenance.
6. Gyro-stabilized.
7. JAN components.
8. RACON beacons.

ALLISON RADAR SALES CORP.
Exclusive Manufacturers' Distributors
ALINE RHONIE, President
11 West 42nd St., New York 18
PEnn 6-5811-12

NEW All-Metal... All-Weather MOUNT



COMPLETE and BALANCED PROTECTION



(CUP TYPE MODEL #7002)

MET-L-FLEX

All-metal — all-weather cup type shock mounts provide vibration isolation and shock absorption through the widest possible range of operating conditions.

These unit mounts and mounting systems are absolutely uniform—no organic materials — stable characteristics from -90°C. to +175°C. —wide load tolerance—built-in damping for reduced amplification at resonance.

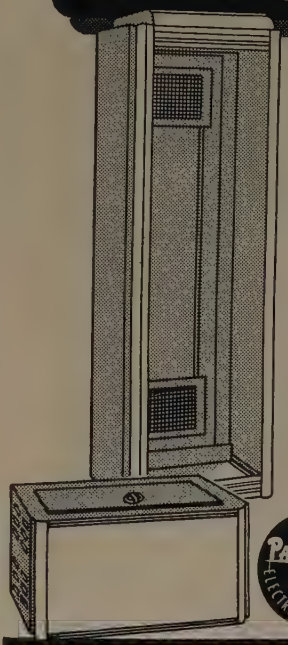
If you have an electronic or delicate equipment mounting problem, you will probably find *Robinson is the answer.*

Write Dept. 804
Write for MET-L-FLEX Data Sheets

ROBINSON AVIATION INC.
TETERBORO, NEW JERSEY
Vibration Control Engineers

CABINETS • CHASSIS • PANELS • RACKS

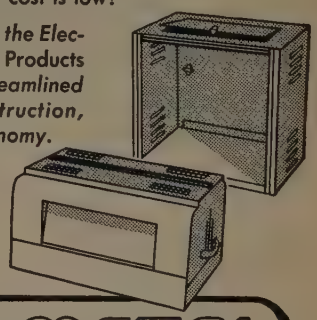
Planning ELECTRONIC EQUIPMENT ?
Investigate the ECONOMIES of PAR-METAL HOUSINGS !



We manufacture Metal Housings for every purpose — from a *small receiver* to a *deluxe broadcast transmitter.* And the cost is low!

Because we *specialize in the Electronics field,* Par-Metal Products excel in *functional streamlined design, rugged construction, beautiful finish,* and *economy.*

Remember, Par-Metal equipment is made by *electronic specialists,* not just a sheet metal shop.



PAR-METAL
PRODUCTS CORPORATION
32-62 — 49th ST., LONG ISLAND CITY 3, N. Y.
Export Dept.: Rocke International Corp.
13 East 40 Street, New York 16, N. Y.

WRITE FOR CATALOG !

Bolometer Amplifier . . .

- Variable Bandwidth
- Tunable Frequency Range
- Voltage Ratio Expander
- Automatic Normalization
- Self Contained Metering
- Recorder Output

USES

The P & B Bolometer Amplifier Model 100 is a quality amplifier designed for use in connection with making electrical measurements of antennas and associated radio-frequency systems. Standing wave ratios may be quickly determined on either a linear or expanded indicating scale.

The tunable, variable bandwidth, band-pass characteristics of the amplifier makes it useful where conditions might render other test equipment useless.

Built to Navy Specifications for research and production testing.

Ask for Bulletin L-100

CHARACTERISTICS

Frequency range—400 cycles—5000 cycles (± 3% calibration accuracy)
Bandwidth—(½ voltage) 6, 12, 22, 50, 100 and 300 cycles
Input Voltage Range
Signal Channel—10^{-2}—10^{-7} volt.
Monitor Channel—10^{-2}—10^{-5} volt.
Expander Operation—10^{-2}—10^{-5} volt.
Input Impedance—250 to 350 ohms.
Meter—logarithmic scale with 100 db decade.
Recorder Output—.01—100 volts @ .01 w. max. (undecaded)
Normalization—output voltage holds within ±¼ db for input changes of ±5 db to both channels.
Bolometer Bias—adjusted in steps of 2% current change over range of 2.1.
Voltage Ratio Expander—8th power expansion.

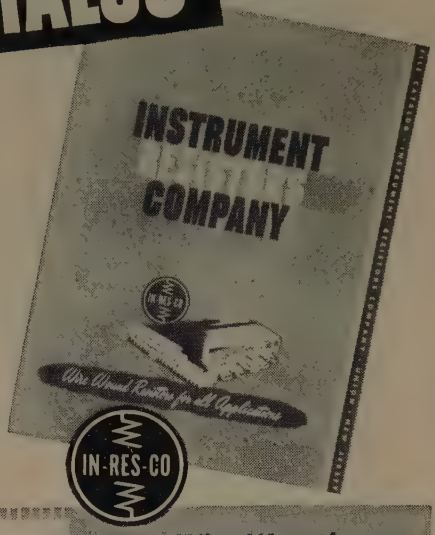
PICKARD & BURNS, INC.
240 Highland Avenue — Needham 94, Massachusetts

when you need resistors—

IT WILL PAY YOU TO CONSULT THE NEW

IN-RES-CO CATALOG

Included are complete descriptions and specifications on wire wound resistors of all types and sizes. Each is precision wound to close tolerance, and many feature special moisture-proofing to assure proper functioning under severest climatic conditions. INRESCO Resistors —available for IMMEDIATE DELIVERY—are supplied in standard or custom types to meet the most unusual design or operational requirements, and are offered at prices that benefit from mass production facilities. A copy of the new INRESCO catalog will be helpful; write for it today. Prices, samples and estimates promptly on other than standard resistors.



INSTRUMENT RESISTORS COMPANY
1036 COMMERCE AVE., UNION, N. J.

Wire Wound Resistors for Every Use in Electronics and Instrumentation

You Are Invited to Attend the Second Annual

AUDIO FAIR

at the

Hotel New Yorker, New York City, October 26, 27, 28, 1950

The event of utmost interest and importance to Broadcast Engineers, Recordists, Sound-on-Film Men, Public Address Men, Audio Hobbyists and Distributors and Dealers.

Presenting again, under one roof, an industry-wide display and demonstration of the latest and best of audio equipment, components and accessories.

Free Registration Banquet Thurs., Oct. 26, 7:30 P.M.

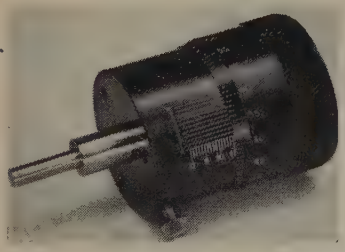
Sponsored by the AUDIO engineering society

in conjunction with it's

ANNUAL MEETING AND CONVENTION

ONE OF OUR

PRECISION PRODUCTS



SPECIAL MICROMETER HEAD

- Invar nut and spindle (Hard chrome plated)
- Anti-back lash screw thread
- Readable in either direction of rotation to .00005

MANUFACTURERS THREAD GRINDING, INC.
P. O. Box 66 EATONTOWN, N. J. ASBURY PARK 1-1019

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 68A)

New Microphone

An advance in microphone engineering is claimed by **The Astatic Corporation,** Conneaut, Ohio, with announcement of a newly perfected unit, the Synabar, Model DR-10 microphone.

Outstanding feature of the Synabar, which is an unidirectional cardioid crystal type, is the use of a special sintered metal to cancel out 15 db front to back. This feature is an achievement for effectiveness is making a new microphone dead to the sound from rear, it is claimed.

The clear-toned performance of the Synabar does not diminish through long service life, thanks to added ruggedness of the advanced construction, the manufacturer declares. Excellent frequency range, from 50 to 10,000 cps, is further enhanced by a response selector switch, which provides choice of ideal pickup characteristics for either crisp voice or general voice and music.

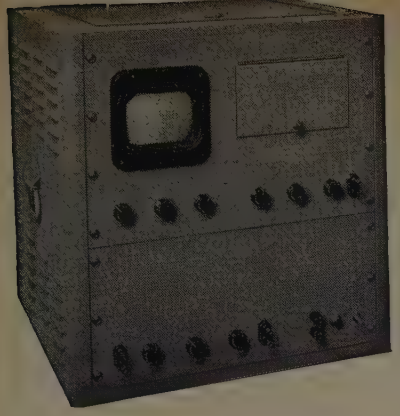
A high impedance microphone, the Synabar has an output level of −54 db. Its crystal element has a special metal-seal protection against moisture or dryness. The finish is satin chrome and the unit is furnished with 20 feet of single conductor shielded cable and detachable concentric cable connector. Available in models with or without off-on switch.

Multichannel Sampling Switch

The Applied Science Corporation of Princeton, Princeton, N. J., announces the development of a high-speed multichannel sampling switch.

The device illustrated is an ASCOP Model 1-30-30S. The motor and switch are designed as a single packaged unit weighing 53 ounces. Over-all dimensions are 5 inches long × $3\frac{1}{3}$ inches wide × $3\frac{9}{16}$ inches high.

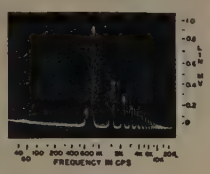
(Continued on page 73A)



In only 1 SECOND!

COMPLETE AUDIO WAVEFORM ANALYSIS *with the* AP-1 PANORAMIC SONIC ANALYZER

Oscillograph of waveform to be analyzed →



Panoramic Sonic Analysis of the same waveform

Provides the very utmost in *speed, simplicity* and *directness* of complex waveform analysis. In only one second the AP-1 *automatically* separates and measures the frequency and amplitude of wave components between 40 and 20,000 cps. Optimum frequency resolution is maintained throughout the entire frequency range. Measures components down to 0.1%.

- Direct Reading
- Logarithmic Frequency Scale
- Linear and Two Decade Log Voltage Scales
- Input voltage range 10,000,000:1

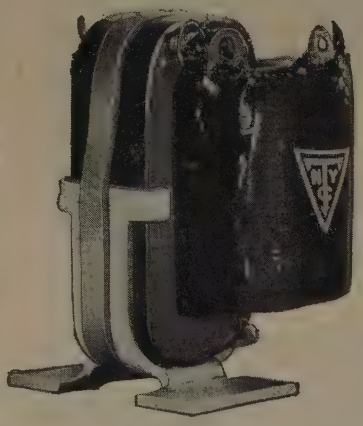
AP-1 is THE answer for practical investigations of waveforms which vary in a random manner or while operating or design constants are changed. If your problem is measurement of harmonics, high frequency vibration, noise, intermodulation, acoustics or other sonic phenomena, investigate the overall advantages offered by AP-1.

Write NOW for complete specifications, price and delivery.

See us in Booth 428 at the Fifth National Instrument Exhibit, Buffalo, N.Y., September 18-22, 1950.

PANORAMIC RADIO PRODUCTS INC MOUNT VERNON N Y

H IS FOR HORNET CLASS H HIGH VOLTAGE KNOW HOW AND THEY MAKE AN H OF A DIFFERENCE



HORNET Transformers provide minimum size, maximum efficiency and greatest life expectancy in transformers for portable and airborne equipment.

Because they are manufactured of newly developed Class H materials — silicones, fiberglas and special steels — HORNET miniature transformers can be operated at temperatures far in excess of the so-called "normal range."

Compare These Typical Volume and Weight Figures

PLATE TRANSFORMER: Primary 115V., 380/1600cps. Secondary 860V. C.T. 70 MA-RMS, 60 V.A. (85 deg.C. ambient, 50,000 ft. alt.)

	Max. Oper. Temp. Deg.C.	Volume Cu. Ins.	Relative Volume Percent	Weight Pounds	Relative Weight Percent
Hermetically Sealed (Class A insulation)	105	21.3	100	2.0	100
Open Construction (Class A insulation)	105	11.0	54.2	1.2	60
HORNET (Class H insulation)	200	6.5	30.5	.33	16.5

The HORNET represents a combination of ingenious design, modern materials, and radically different manufacturing techniques which opens vast new fields in transformer construction and application.

Send for your copy of Bulletin B-300, containing detailed size, weight and rating information on Hornet Transformers and Reactors.

NEW YORK TRANSFORMER CO., INC.

ALPHA, NEW JERSEY

SMALL

PARTS

Cost less when made by

MULTI-SWAGE

The economy way to get
a million small parts
similar to these —

Examine the tubular and solid metal parts shown here twice size. If you use anything similar . . . in quantities of over a million . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,
Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

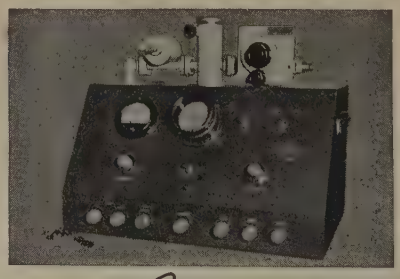
Test Equipment FOR RADAR and PULSE APPLICATIONS

MODEL 705 WOBBULATOR

Swept signal output with center frequency adjustable from 2 to 500 mc.
Continuous swept output adjustable from 0 to 100 mc./sec. with 0.1 volt output at 50 ohms.
Internally synchronized scope with detectors and amplifiers.
High and low impedance shielded traveling detectors.
Output designed for making response measurements at 3000 mc., IF frequencies, and Video.

MODEL 708 SPECTRUM ANALYZER

Frequency range—8500 mc to 9600 mc.
Receiver—Double conversion superheterodyne.
IF bandwidth—approximately 10 kc.
Sweep frequency—10 cps to 25 cps.
Minimum frequency dispersion—1 mc/inch.
Maximum frequency dispersion—10 mc/inch.
Signal input attenuator—100 db linear.
Power—115V or 230V, 50 cps to 800 cps.



Write for complete technical data

Canoga *corporation*

14315 Bessemer St., Van Nuys, Calif. • Box 361

Gold Plated

TUNGSTEN and MOLYBDENUM GRID WIRE

Made to meet your specifications . . . for gold content, diameter and other requirements.

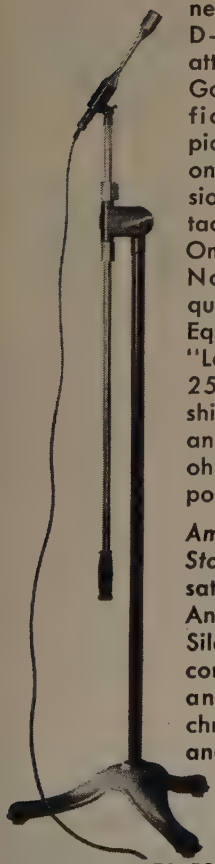
Write for details and list of products

SINCE 1901

SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

Truly AN American BEAUTY

Providing full vision for artist and audience, this new American Dynamic D-33 Microphone is attractively finished in Gold and Black and efficient for all Audio pickup. Easily mounted on stand or for suspension use. Quickly detachable for hand use. Omnidirectional pickup. No pre-amplifier required. Weight, 7 oz. Equipped with Cannon "Latch Lock" plug and 25 ft. two conductor shielded cable. Impedance; 30-50 and 250 ohms. Available in all popular impedances.



American's New Floor Stand adds greater versatility for your staging. Angle adjustment . . . Silent, positive fingertip control . . . Upper rod and fittings polished chrome. Lower rod and angle adjustment, satin black. Microphone mounting, standard 5/8"x 27 thread.

WRITE FOR CATALOG

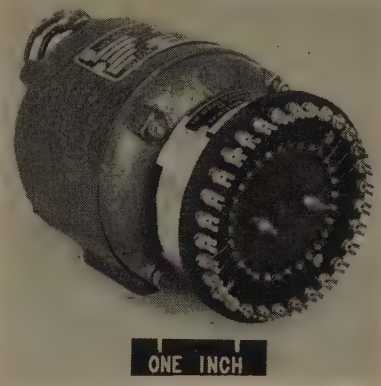
American Microphone Co.
370 S. Fair Oaks Avenue, Pasadena 1, Cal.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 70A)

The synchronous driving motor is rated at 1,800 rpm, 115 volt single phase, 60 cps. Since the switch is driven directly by the motor shaft at a rate of 30 revolutions per second, sampling of all 30 "break-before-make" channels is in synchronism with the ac line voltage. This synchronous switching is ideally suited for the display of the sampled information on a C-R oscillograph.



The 30 active contact pins are connected to terminal lugs to facilitate wiring by the user.

A similar unit is available with all 60 contacts made accessible. With its shorting-type wiper, this device features great versatility in possible switching arrangements.

(Continued on page 75A)

Stable at temperatures from −70° to +400°F.

The non-melting silicone insulating and water-proofing compound for ignition systems and electronic equipment.

DC 4 COMPOUND MEETS ALL REQUIREMENTS OF AN-C-128a

DC 4 is highly resistant to oxygen, ozone, hydrogen peroxide and to deterioration caused by corona discharge. It is more water repellent than paraffin or waxes.

POWER FACTOR, up to 10 megacycles . . 0.001
VOLUME RESISTIVITY, ohm centimeters . . 10^{12}
DIELECTRIC STRENGTH, volts/mil . . 500

For more information about Dow Corning 4 Compound; Dow Corning 200 Fluids as liquid dielectrics; DC 1208, the water repellent for glass and ceramics; Silastic, the Dow Corning Silicone rubber for use at −100° to 500° F; Dow Corning Silicone (Class H) Electrical Insulating Varnishes and Resins.

For more data phone or write

Dow Corning
FIRST IN SILICONES

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta • Chicago • Cleveland • Dallas
Los Angeles • New York
Canada: Fiberglas Canada, Ltd., Toronto
Great Britain: Albright and Wilson, Ltd., London

HICKOK

Laboratory MODEL
TUBE TESTER

MODEL 539

Especially Accurate

- Dynamic Mutual Conductance . . . Readings in Micromhos.
- Permits choice of 3 A.C. signals, .25, .5, and 2.5 volts.
- Vernier adjustment permits accurate setting of grid voltage.
- Optional self-bias arrangement.
- Provision for insertion of plate milliammeter for measuring plate current.
- Separate A.C. meter measures line voltage at all times.
- D.C. grid bias and D.C. plate and screen voltages.
- Tube life and gas test for accurate matching of tubes.
- Tests all tubes normally encountered in all phases of electronic work.
- Designed with professional accuracy for engineers and engineering technicians.

See the Model 539 at your jobbers or write for additional information today!

The HICKOK ELECTRICAL INSTRUMENT COMPANY
10551 Dupont Ave., Cleveland 8, O.

1910 Our 40th Anniversary 1950

MORE GEO. STEVENS COIL WINDING EQUIPMENT IS IN USE THAN ALL OTHER MAKES COMBINED!

• **MORE OUTPUT . . . LOWER COSTS . . .** from *EXCLUSIVE* SPEED FEATURE. Universal motors permit variable speeds without changing belts and pulleys. Coil design permitting, speeds as high as 7500 RPM are not uncommon.

• **PORTABILITY.** Conveniently carried from place to place. Machines come mounted on bases to constitute one complete unit.

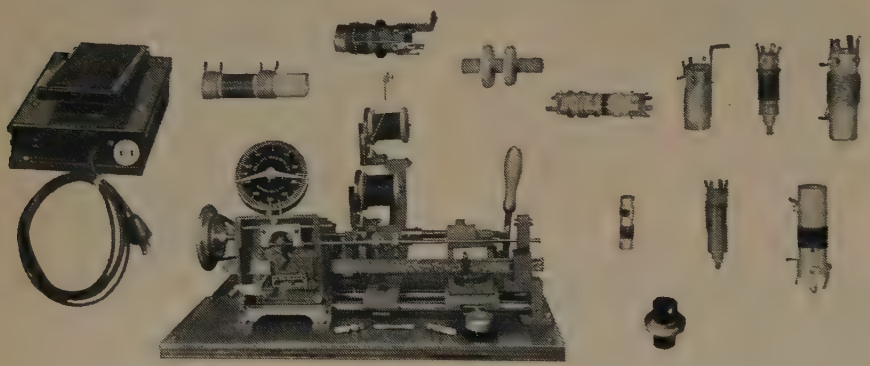
• **MUCH LOWER ORIGINAL COST.** The same investment buys more GEO. STEVENS machines than any other coil winding machines.

• **LONG LIFE.** Most of the original GEO. STEVENS machines bought 14 years ago are still operating daily at full capacity.

• **MUCH FASTER CHANGING OF SET-UPS** than any other general purpose coil winding machine. Quickly changed gears and cams save time between jobs.

• **VERY LOW MAINTENANCE.** Replacement parts are inexpensive, can be replaced in minutes, and are stocked for "same day" shipment, thus saving valuable production time.

• **EASIEST TO OPERATE.** In one hour, any girl can learn to operate a GEO. STEVENS machine.



Progressive universal winding machine, Model 125, handles space wound coils and solenoids up to 8" in length, progressive universal coils up to 4" in length and 3" in diameter, universal coils up to ¾" in width, and I.F. coils. Winds wire from 20 to 44 gauge. Cams are stocked from ¾" to 1/16" in decrements of 1/64". Sizes larger than ¾" or less than 1/64" are made upon request.

Cam, gears and idler forming the pattern are enclosed in front. Traverse rack is driven by change gears and idler enclosed in back of the head. The traverse rack has an adjustable stop to insure return to identical starting position. Large ball bearings on head stock spindle give long life and easy running. Ball bearing tailstock with spring tension lever permits quick change of coil forms.

Standard equipment: ¼ H.P. universal motor, foot operated speed controller, V belt drive, and double spool carrier with two adjustable oilite bearing tensions to control wire during winding.

Dial Counter (Model 50 or 51) with 6" full vision clock dial, accurately registers all turns.

There is a GEO. STEVENS machine for *every* coil winding need. Machines that wind ANY kind of coil are available for laboratory or production line. . . . Send in a sample of your coil or a print to determine which model best fits your needs. Special designs can be made for special applications. Write for further information today.

World's Largest Manufacturer of Coil Winding Machines

REPRESENTATIVES

Frank Tatro
6022 No. Rogers Ave., Chicago 30, Illinois
Ralph K. Reid
1911 W. 9th St., Los Angeles 6, California
R. F. Staff & Co.
1213 W. 3rd St., Cleveland 13, Ohio

GEO. STEVENS MFG. CO., INC.
Pulaski Road at Peterson
Chicago 30, Illinois

Dependable PERFORMANCE at LOWER COST

H&P TOWER LIGHTING EQUIPMENT

H & P lighting equipment, consistently specified by outstanding radio engineers, is furnished as standard equipment by most leading tower manufacturers.

300 MM CODE BEACON

Patented ventilator dome circulates the air, assures cooler operation, longer lamp life. Concave base with drainage port at lowest point. Glass-to-glass color screen supports virtually eliminate color screen breakage. Neoprene gaskets throughout. CAA approved

MERCURY CODE FLASHER

Lifetime-lubricated ball bearings. No contact points to wear out. Highest quality bronze gears Adjustable, 14 to 52 flashes per minute

SINGLE and DOUBLE OBSTRUCTION LIGHTS

Designed for standard A-21 traffic signal lamps Prismatic globes meet CAA specifications.

"PECA" SERIES PHOTO-ELECTRIC CONTROL

Turns lights on at 35 f.c.; off at 58 f.c., as recommended by CAA. High-wattage industrial type resistors. Low-loss circuit insulation.

ALSO COMPLETE LIGHT KITS FOR A-2, A-3, A-4 and A-5 TOWERS

PROMPT SERVICE and DELIVERY

First-day shipments out of stock. Immediate attention to specifications and unusual requirements

WRITE OR WIRE FOR CATALOG AND DETAILED INFORMATION

HUGHEY & PHILLIPS
TOWER LIGHTING DIVISION
326 N. LA CIENEGA BLVD.
LOS ANGELES 48, CALIF.
60 E. 42ND ST. NEW YORK 17, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 73A)

Recent Catalog

• • • An 8-page booklet, entitled "Installation Instructions and Suggested Uses for Stephens Tru-Sonic High-Fidelity Audio Equipment," may be obtained by writing to **Stephens Mfg. Corp.**, 8538 Warner Dr., Culver City, Calif.

Remote Radio Pickup and and Mobile Transmitter Link Equipment

Radio Engineering Laboratories, Inc., 36-40 37 St., Long Island City, L. I., N. Y., are now producing the new REL Model 695, 50 watt, 153-Mc FM remote pickup equipments. A 12-volt dc power supply unit is available for pickup truck operation. This equipment is of interest to broadcasters, not only for regular program pickup use but for emergency broadcasts because the program can be on the air as soon as the pickup truck gets its microphones to the site of the remote. Another use is as an emergency studio to transmitter link to replace normal facilities during temporary failures due to storm or other causes.

(Continued on page 77A)

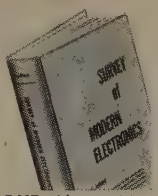
SURVEY OF MODERN ELECTRONICS

By Paul G. Andres
Illinois Institute of Technology

Sept., 1950 522 pages 380 illus. $5.75

GIVES TESTED MATERIAL USED BY MANY MANUFACTURERS

Emphasizes the practical application of electronic principles in industry today. States vacuum tube fundamentals. Gives use of all types in communication, instrumentation, control, induction and dielectric heating. Covers proximity fuse, automatic pilot, radar, and many other modern devices. Draws data, circuits, and illustrations from nearly every manufacturer in the field.



APPROVAL COUPON

JOHN WILEY & SONS, INC., DEPT. PI-950
440 Fourth Ave., New York 16, N.Y.

Send me, on 10 days' approval, Andres' *Survey of Modern Electronics*. Either I will remit $5.75 plus postage, or I will return book postpaid.

Name .....

Address .....

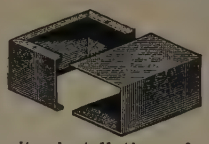
City .....Zone ....State .....

Employed By .....

(Offer not valid outside U.S.)

FROM THE SMALLEST TO THE LARGEST
YOU'LL DO BETTER WITH BUD

MINIBOXES



There are thousands of uses in the fields of radio and electronics for these new boxes. They are made from heavy gauge aluminum. The design of the box permits installation of more components than would be possible in the conventionally designed box of the same size. It is of two piece construction, each half forming three sides. The flange type construction assures adequate shielding. Available in etched aluminum finish and gray hammerloid finish.

Catalog Numbers Gray	Etched	Length	Width	Height	Dealer Cost
CU-2100	CU-3000	2¾"	2⅛"	1⅝"	$ .50
CU-2101	CU-3001	3¼"	2⅛"	1⅝"	.50
CU-2102	CU-3002	4"	2⅛"	1⅝"	.50
CU-2103	CU-3003	4"	2¼"	2¼"	.70
CU-2104	CU-3004	5"	2¼"	2¼"	.72
CU-2105	CU-3005	5"	4"	3"	.72
CU-2106	CU-3006	5¼"	3"	2⅛"	.72
CU-2107	CU-3007	6"	5"	4"	.81
CU-2108	CU-3008	7"	5"	3"	1.05
CU-2109	CU-3009	8"	6"	3½"	1.68
CU-2110	CU-3010	10"	6"	3½"	1.80
CU-2111	CU-3011	12"	7"	4"	2.34
CU-2112	CU-3012	17"	5"	4"	2.76
CU-2113	CU-3013	10"	2"	1⅝"	.78
CU-2114	CU-3014	12"	2½"	2½"	.96
CU-2115	CU-3015	4"	2"	2¾"	.60
CU-2116	CU-3016	4¼"	2¼"	1½"	.66

Prices 10% higher west of the Mississippi River

ADD-A-RACK SERIES

It has always been necessary to buy special racks without louvers on one side to obtain a maximum of panel space with a minimum of floor space. Now, you no longer need to buy a whole new cabinet when you want additional panel space. Through our new and exclusive Add-a-Rack series, BUD not only offers additional racks at a lower cost, but provides you with a sturdier, better looking assembly.

The illustration above at left shows two Add-a-Rack cabinets assembled together. The illustration above at right shows the unique and ingenious method of adding a unit to your present equipment. Instead of buying an entire new outfit, you purchase only four parts: (1) a door, (2) a top, (3) a bottom and (4) an Add-a-Rack coupling unit. The right (or left) hand side of your present relay rack is removed and replaced by the Add-a-Rack coupling unit; next, a top and bottom is fastened into place, and the side taken from the first rack is fastened onto the second rack which has been added. Place the additional door into position and you have two racks properly and efficiently coupled together.

In the same simple way, more racks can be added at any time and every one will be in a CONTINUOUS ONE-PIECE assembly.

This series is available in two ways: (1) a double unit consisting of two racks and the Add-a-Rack coupling unit, (2) Add-a-Rack unit, consisting of a door, a top, a bottom and an Add-a-Rack coupling unit. These units are furnished with all necessary assembling and panel mounting hardware.

BUD RC-7756 Casters will fit this unit. Casters are not included in price of cabinet.

Add-a-Rack Unit	To Add-a-Rack to	Overall Height	Panel Space	Dealer Cost
AR-1778	CR-1774	46 1/16"	36¾"	$26.25
AR-1775	CR-1771	47 5/16"	42"	32.50
AR-1776	CR-1772	66 9/16"	61¼"	40.75
AR-1777	CR-1773	82 5/16"	77"	48.00

Complete unit, consisting of the knocked-down parts necessary for two relay racks coupled together.

		Dealer Cost
CR-1779	two coupled relay racks same size as CR-1774	$54.75
CR-1780	two coupled relay racks same size as CR-1771	67.95
CR-1786	two coupled relay racks same size as CR-1772	83.05
CR-1799	two coupled relay racks same size as CR-1773	98.40

Prices are 10% higher west of the Mississippi River.

The above are only a few of our standard items. Send for catalog for complete information. We welcome the opportunity of quoting from your blue prints on special steel or aluminum housings.

BUD

BUD RADIO, INC.

2110 EAST 55TH STREET CLEVELAND 3, OHIO

THE RADIO ENGINEERING SHOW

Dates: March 19-22, 1951
Monday through Thursday
Place: Grand Central Palace, New York City
at Lexington Ave. and 46th St.

Plan to Come!

252 Exhibits—17,689 Attended in 1950

JUST PUBLISHED!

A definitive new work on the theory and relative merits of the traveling-wave tube, and its importance to present-day communications and the entire field of microwave electronics.

TRAVELING WAVE TUBES

By J. R. PIERCE, Ph.D.
Member of the Technical Staff
Bell Telephone Laboratories, Inc.

BEGINNING with a clear and simple description of the traveling-wave tube and a simple exposition of its theory, this book treats in a unified manner problems such as those of circuit impedance, loss, gain, power, and noise in traveling-wave tubes.

In presenting this well-rounded treatment, the author has provided much new material in addition to using previously published information, and he has applied to both a common notation and uniform development.

The first chapter is introductory, showing the nature of traveling-wave tubes, their advantages and disadvantages, and in general their place in present-day communications and the trend of their development. Then follows the description of the tube itself, and a concise, specialized analysis of its operation. Following chapters discuss slow-wave circuits and give a qualitative and quantitative idea of their nature and limitations. Then, simplified equations for the overall behavior of the tube are introduced and solved, and matters such as overall gain, insertion of loss, a-c space-charge effects, noise figure, field analysis of operation and transverse field operation are considered. Power output is discussed, and in the final chapters brief treatments are given of two closely related types of tube—the traveling-wave magnetron amplifier and the double-stream amplifier. Appendices treat various detailed points and contain in easily usable form, material necessary for calculating gain of traveling-wave tubes. In sum, this book provides the broad coverage of principles and the necessary treatment of details for those planning to work with traveling-wave tubes.

EXAMINE THIS BOOK FREE

Use the convenient order form below to obtain an examination copy of this important new work.

Please cut out and mail

D. Van Nostrand Company, Inc. *Publishers*
250 Fourth Avenue, New York 3, N.Y. *Since 1848*

Please send me a copy of "Travelling Wave Tubes." Within ten days I will either return the book or send you $4.50, plus a few cents postage.

Name. .....
Address .....
City .....Zone .....State .....

IRE-950

FOR SUPERIOR
PAPER-DIELECTRIC
CAPACITORS
Permanol

G-H "Custom-manufactured" capacitors treated with this highly effective impregnant insure . . . . .

Utmost protection against voltage breakdown . . .

Maximum stability under adverse climatic conditions

Low power-factor change with frequency . . .

Permanent, non-ageing characteristics . . .

GH can supply you with PERMANOL treated capacitors to your own specifications. Any reasonable capacity, tolerance or working voltage . . . any size or type of container . . . small or production quantities.

One of the best equipped capacitor manufacturing plants on the Pacific Coast

GIRARD-HOPKINS
1000 40th Avenue, Oakland 1, Calif.

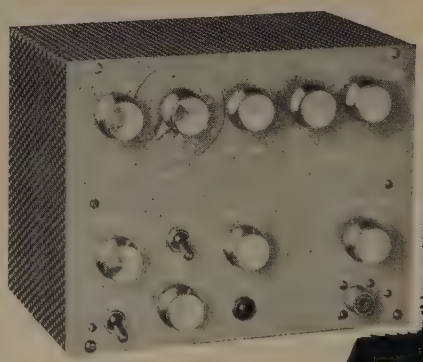
The New STAVER
MINI-SPRING
TRADE MARK REG. AND PAT. PEND.

A quality Tube Guard that is Bargain Priced

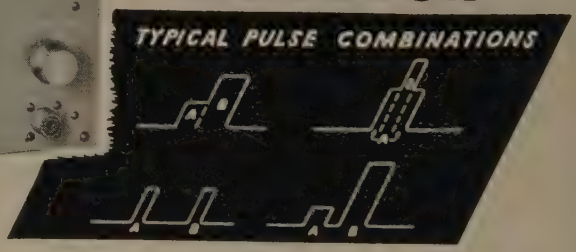
Gives support two ways—Keeps pressure downward and gives sideway support. The spring action is constant and resilient permanently. Send for catalog sheet.

THE Staver COMPANY
INCORPORATED

91 PEARL ST. • BROOKLYN 1, N. Y.
ULSTER 5-6303



THE *Berkeley*
MODEL 902
DOUBLE PULSE GENERATOR



BRIEF SPECIFICATIONS

PULSE DURATION individually adjustable from 0.15 to 1.5 microseconds; RISE TIME is .05. DECAY TIME 0.10 microseconds. SPACING between pulses variable from −0.5 to +3 microseconds. REPETITION RATE adjustable in 3 ranges, 1 to 10, 10 to 100 and 100 to 1000 cycles; can be externally triggered. OUTPUT IMPEDANCE approximately 400 ohms, maximum output voltage, −200 v. CONTROL CALIBRATION ACCURACY ±5% over entire range.

The Berkeley Double Pulse Generator produces two pulses individually controllable in width, amplitude and time relation to each other. Pulse amplitude is individually adjustable without cross effect from 0 to +50 v. and 0 to −200 v. A fine control, plus a 10 to 1 step attenuator permits varying the amplitude of both pulses after mixing.

TYPICAL APPLICATIONS...Resolution tests of high speed scaling circuits, response simulation of scintillation and proportional counters, evaluation of electronic gate and switch response, TV equipment testing, characteristic checks of wide band amplifiers, etc.

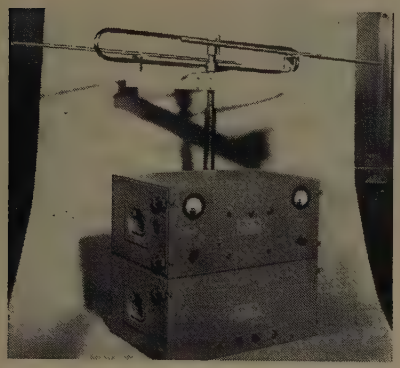
COMPLETE INFORMATION *is yours for the asking; please request Bulletin E-902.*

Berkeley Scientific Company
SIXTH & NEVIN AVENUE • RICHMOND, CALIFORNIA

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

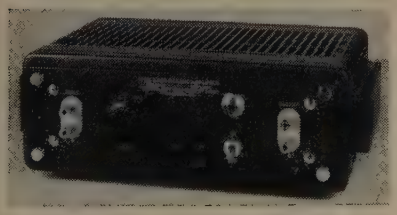
(Continued from page 75A)



The photograph shows the ac power supply and the transmitter, and the antenna which usually is mounted atop the pickup truck during operation.

Wide-Band Decade Amplifier

Type 500-A wide-band decade amplifier has been developed by **Technology Instrument Corp.,** 1058 Main St., Waltham, Mass., for general laboratory use and for special applications requiring zero phase shift on high stability of gain. To increase the general utility of the amplifier, compact construction, cabinet or rack mounting, and ac operation from a self-contained power supply have been incorporated in the design.



Input impedance is high enough to permit measurements in most circuits without upsetting normal conditions.

Output impedance is low enough to permit operation into a wide range of loads without causing a variation from the indicated gain of 10,000 or 1,000 times.

Maximum output of 20 v on any gain setting insures sufficient amplitude for the operation of most devices used in conjunction with general purpose laboratory amplifiers.

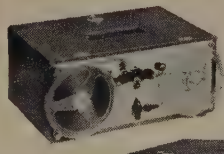
Zero phase shift from 20 cps to 100 kc (all instruments adjusted as close as practical to zero—some might exhibit an error of 2° unless requested otherwise) makes possible the extension of phase measurements of 5-mv levels, when used with TIC Type 329 phase meter.

Gain stabilized by feedback, so that it is constant with line voltage or tube changes.

(Continued on page 78A)

MAGNECORDER

Professional Tape Recorders Fit every purpose — every purse!



PT6 SERIES
—world's most widely used professional tape recorder.

PT63 SERIES
— 3 heads to erase, record, and monitor from the tape.

PT7 SERIES
— A complete console for only $950.00. Models for portable or rack mount also available. Outstanding features and flexibility.

FOR FIDELITY

No other recorder offers such high fidelity at such a low price! Frequency response 50-15 kc ± 2 db. Signal-noise ratio: 50 db. Flutter less than 0.3%. Meets N.A.B. standards.

FOR FLEXIBILITY

For delayed studio or network broadcasts, a Magnecorder can be mounted in a rack or console cabinet. For remotes, slip it into its really *portable* cases. Amplifiers for every purpose—single or multi-channel.

FOR FEATURES

Magnecord sets the pace! New or old, your Magnecorder can have 3 heads (separate erase, record, and playback heads) to permit monitoring from the tape. 3 speeds (15", 7½" and 3¾" — up to an *hour* on a 7" reel) now available on both PT6 and PT63 equipment. Magnecorders are fail-safe, sturdy! Features to fit your every need.

Write for NEW CATALOG

MAGNECORD, Inc. Dept. P9
360 N. Michigan Ave., Chicago 1, Ill.

Send me latest catalog of Magnecord equipment.

Name.....

Company.....

Address.....

City.....State.....

PROFESSIONAL CARDS

LESTER W. BAILEY
Registered Patent Agent
Senior Member IRE
PATENT OFFICE PRACTICE specializing in
ELECTRONICS MECHANICS
RADIO
LINCOLN-LIBERTY BUILDING
PHILADELPHIA 7
Broad & Chestnut Streets Rittenhouse 6-3267

ALFRED W. BARBER LABORATORIES
Specializing in the Communications Field and in Laboratory Equipment
Offices, Laboratory and Model Shop at:
32-44 Francis Lewis Blvd., Flushing, L.I., N.Y.
Telephone: Independence 3-3306

HAROLD J. BROWN
Vibrators
Vibrator Power Supplies
Electrical Contact Systems
Mattapoisett, Mass.

W. J. BROWN
International Electronics Consultant
AT PRESENT IN GREAT BRITAIN
Will undertake assignments for American or British Clients. Please address inquiries to 11 Public Square, Cleveland 13, Ohio.
TO 1-6498 FA-1-0030

EDWARD J. CONTENT
Acoustical Consultant
Functional Studio-Theater Design
FM — Television — AM
Audio Systems Engineering
Roxbury Road Stamford 3-7459
Stamford, Conn.

CROSBY LABORATORIES, INC.
Murray G. Crosby & Staff
Radio-Electronic Engineering,
Research & Development
FM, Communications, TV
Test Equipment
Offices, Laboratory & Model Shop at:
126 Herricks Rd., Mineola, N.Y.
Garden City 7-0284

Richard B. Schulz
Electro-Search
Radio-Interference Reduction;
Development of
Interference-Free Equipment,
Filters, Shielded Rooms
515 W. Wyoming Ave., Philadelphia 40, Pa.
GLadstone 5-5353

ELK ELECTRONIC LABORATORIES
Jack Rosenbaum
Specializing in the design and development of
Test Equipment for the communications, radar and allied fields.
333 West 52nd St. Telephone:
New York 19, N.Y. PLAZA 7-0520

WILLIAM L. FOSS, INC.
927 15th St., N.W. REpublic 3883
WASHINGTON, D.C.

PAUL GODLEY CO.
Consulting Radio Engineers
P.O. Box J. Upper Montclair, N.J.
Offs & Lab.: Great Notch, N.J.
Phone: Montclair 3-3000
Established 1926

HERMAN LEWIS GORDON
Registered Patent Attorney
Patent Investigations and Opinions
Warner Building 100 Normandy Drive
Washington 4, D.C. Silver Spring, Md
National 2497 Shepherd 2433

HOGAN LABORATORIES, INC.
John V. L. Hogan, Pres.
APPLIED RESEARCH, DEVELOPMENT, ENGINEERING
Est. 1929. Exceptionally competent staff. Electronics, Optics, Mechanisms, Facsimile Communication, Electro-sensitive recording media, Instrumentation.
155 Perry Street, New York 14 CHelsea 2-7855

MEASUREMENTS CORP.
RESEARCH & MANUFACTURING ENGINEERS
Harry W. Houck Jerry B. Minter
John M. van Beuren
Specialists in the Design and Development of Electronic Test Instruments
BOONTON, N.J.

PICKARD AND BURNS, INC.
Consulting
Electronic Engineers
240 HIGHLAND AVE.
NEEDHAM, MASS.

PAUL ROSENBERG ASSOCIATES
Consulting Physicists
Main office: Woolworth Building, New York 7, N.Y.
Cable Address PHYSICIST Telephone WOrth 2-1939
Laboratory: 21 Park Place, New York 7, N.Y.

SERVO CORPORATION OF AMERICA
Henry Blackstone, President
Consultants on
Electronic Control Problems
for Industry
New Hyde Park Long Island, N.Y.

TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS CONSULTANTS
RADIOTELETYPE - FREQUENCY SHIFT
INK SLIP RECORDING - TELETYPE NETWORKS
121 Spencer Place, Mamaroneck, N.Y.

WHEELER LABORATORIES, INC.
Radio and Electronics
Consulting — Research — Development
R-F Circuits — Lines — Antennas
Microwave Components — Test Equipment
Harold A. Wheeler and Engineering Staff
Great Neck, N.Y. Great Neck 2-7806

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 77A)

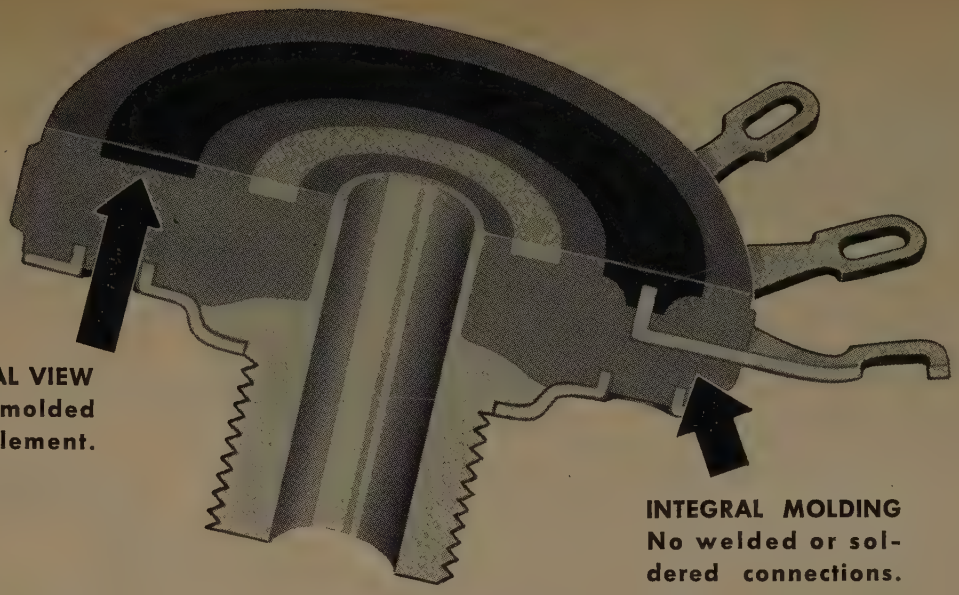
Two-Pole Mercury Plunger Relays

Ebert Electronics Corp., 185-09 Jamaica Ave., Hollis 7, L. I., N. Y., announces the release of its new two-pole mercury plunger relays. Based on many years of experience producing a single-pole mercury relay of unusual reliability (10,000,000 operations without failure), a new design has been developed incorporating two of the standard EMT tubes in one coil structure. This produces an efficient arrangement for loads up to 35 amperes 115 v ac, or 25 amperes 200 v ac with minimum size and cost.

The over-all dimensions of the two-pole relay (Type EM-4) are $4\frac{3}{8}$ inches high by $3\frac{3}{8}$ inches wide by $2\frac{1}{4}$ inches deep. It is available with contacts normally open or normally closed. For special applications it is also manufactured with one contact normally open, the other normally closed. This permits instantaneous switch from one circuit to another.

The reliability of these relays lies in the hermetic, dustproof structure, based on heavy tungsten contacts in a hydrogen-filled glass tube. Contact is made from mercury to mercury when the internal magnetic plunger is energized.

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

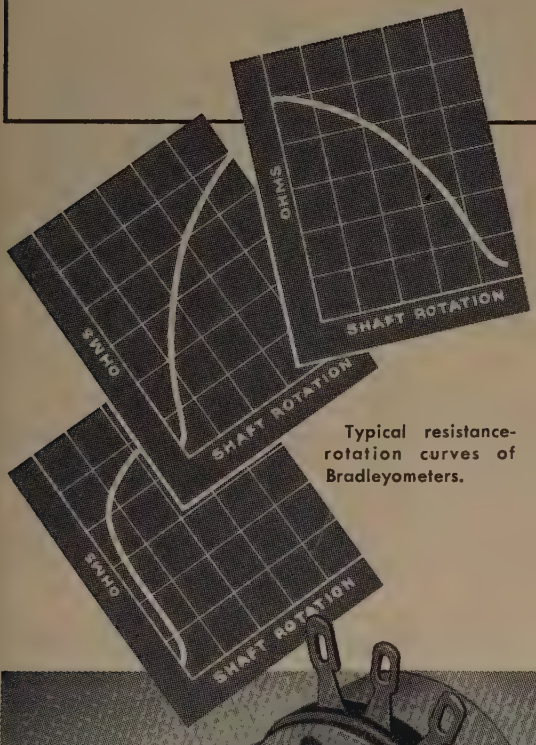


SECTIONAL VIEW
of solid molded
resistor element.

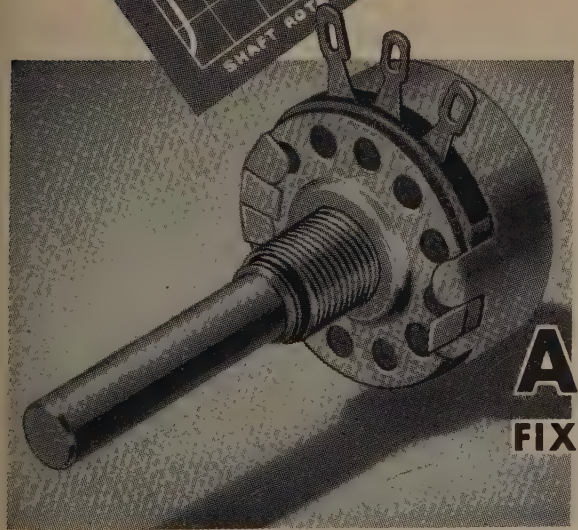
INTEGRAL MOLDING
No welded or sol-
dered connections.

Any Resistance-Rotation Curve

can be permanently molded into the Type J Bradleyometer



Typical resistance-rotation curves of Bradleyometers.



The Type J Bradleyometer can be built to produce any resistance-rotation curve because, during manufacture, the solid molded resistor can be varied in resistance throughout the circumference of the ring.

It is not a film or paint type resistor. The resistor unit is molded as one piece with terminals, face plate, and threaded bushing imbedded in the molded piece. After molding, the resistor material is no longer affected by heat, cold, moisture, or age. The contact brush actually improves with age.

Type J Bradleyometers can be supplied in single, dual, or triple unit construction for rheostat or potentiometer applications. A built-in line switch is an optional feature on single and dual models. Specifications sent upon application.

Allen-Bradley Co.
114 W. Greenfield Ave., Milwaukee 4, Wis.

A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers of radio and electronic equipment

QUALITY

ASTATIC BOOSTER
MODEL BT-1
LIST PRICE $29.95

NEVER BEFORE such quality features in a low-priced booster. Choice of conventional styling in a metal cabinet with rich mahogany woodgrain finish or modern design in dark brown plastic. Simplified controls —single tuning knob with continuous tuning through both TV and FM bands.

ASTATIC BOOSTER
MODEL BT-2
LIST PRICE $32.50

ASTATIC LEADS

ASTATIC BOOSTER
MODEL AT-1
LIST PRICE $49.50

THE TV AND FM BOOSTER FIELD IN THESE THREE IMPORTANT WAYS

1

COMPLETE LINE—Four models from which to choose, with variety of handsome cabinet styling.

2

UNEQUALLED PERFORMANCE —Astatic engineering leadership assures superior booster performance . . . unequalled improvement of TV and FM reception.

3

WIDEST PRICE RANGE—A price to fit every purse, assuring top volume sales.

ASTATIC four-tube deluxe models—no other booster can do so much in improving TV picture contrast and clarity, in improving sound, in eliminating interference. Feature exclusive variable gain control and dual-tuning. Model AT-1 in fine furniture finish mahogany, model AT-1B in blond wood cabinet.

ASTATIC BOOSTER
MODEL AT-1B
LIST PRICE $51.50

Write for New, Full-Color Folder giving Complete Details on Astatic Boosters

THE Astatic CORPORATION
ASTATIC
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

MARQUETTE UNIVERSITY, IRE-AIEE BRANCH

Field Trip through General Electric X-Ray Corporation of West Allis, Wisconsin; June 6, 1950.

Business Meeting; Election of Officers; June 29 1950.

Business Meeting; July 13, 1950.

AKRON

"Military Aircraft Communication Systems," by L. B. Hallman, Wright-Patterson Air Base; April 18, 1950.

"Automatic Flight Control," by James Anast, Air Materiel Flight Command; Election of Officers; May 16, 1950.

BUENOS AIRES

Film, "Atomical Physics," by H. T. Magno; June 16, 1950.

"Modern Developments of the Impulse Governed Oscillator's Technique," by H. B. R. Boosman; July 7, 1950.

"Some Mathematics Aspects of the Communication's Theory," by A. G. Dominquez; July 21, 1950.

"Facsimile," by M. V. Sarli; August 4, 1950.

CLEVELAND

"Battery-Capacitor Pulse Power Supplies," by W. H. Fritz, National Carbon Company; February 23, 1950.

"Large Scale Operational Research in Industry as Illustrated by the Great Lakes Radar Studies," by C. M. Jansky, Jr., and S. L. Bailey, Jansky & Bailey; March 23, 1950.

"Discussion of Color Television Systems," by Students from John Carroll University, Case Institute and Fenn College; April 27, 1950.

Inspection Trip through WXEL Television Station; May 11, 1950.

"Television Studio Equipment," by H. B. Fancher, General Electric Company; May 26, 1950.

COLUMBUS

"The T. V. Freeze and The Status of Color Television," by S. L. Bailey, Jansky and Bailey; March 22, 1950.

"High Voltage Power Transmission," by W. J. Sheets, Student, Battelle Memorial Institute; "The Magnetron Oscillator," by J. F. Braeunig, Student, Battelle Memorial Institute; "Two-Phase Symmetrical Components," by H. W. Wilber, Student, Battelle Memorial Institute; "Sonar Systems," by R. A. Orth, Student, Battelle Memorial Institute; April 13, 1950.

Tour of WLW-C Studios and Transmitter; May 31, 1950.

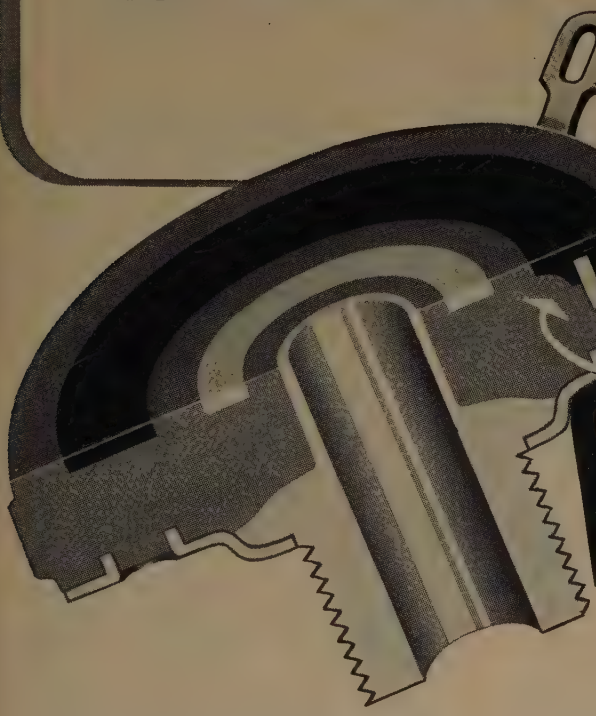
"Cybernetics," by David Huffman, Instructor, Ohio State University; June 22, 1950. Election of Officers; June 22, 1950.

EMPORIUM

"Color Television," by R. M. Bowie, Sylvania Electric Products Inc.; August 18, 1950.

(Continued on page 40A)

DID YOU EVER LOOK INSIDE AN OHMITE Type AB POTENTIOMETER?



The resistance element is SOLID MOLDED— Provides Smoother, Quieter Operation, and Longer Life

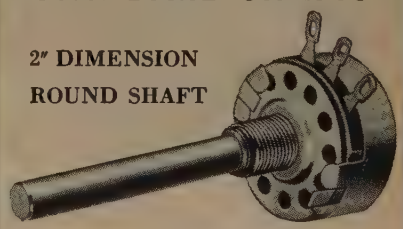
If you were to cut an OHMITE Type AB Potentiometer in half, you would see where these rugged little two-watt units get their reputation for reliability, long life, and smooth, quiet operation. The secret lies in their *unique design.*

The resistance element, for instance, is a thick, solid ring, molded under heat and pressure—not a sprayed film or paint type element. Because of this, the unit is unaffected by heat, cold, moisture, and length of service—and, the low noise level often becomes *less* with use! Furthermore, terminals are *imbedded* in the element, and all parts are corrosion resistant.

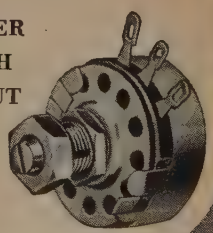
Use these fine components where reliability is important. Available in a wide variety of resistance values, and in three tapers—linear, clockwise logarithmic, and counter-clockwise logarithmic.

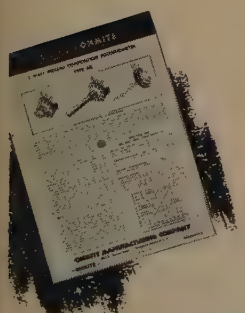
AVAILABLE FROM STOCK IN TWO STANDARD SHAFTS

2" DIMENSION ROUND SHAFT



SCREWDRIVER SHAFT WITH LOCKING NUT





AVAILABLE AT ALL OHMITE DISTRIBUTORS

Write for **BULLETIN 131A**

OHMITE MANUFACTURING CO.
4860 Flournoy St., Chicago 44, Illinois

Be Right with **OHMITE**

Reg. U. S. Pat. Off.

RHEOSTATS • RESISTORS • TAP SWITCHES

Q-max

TRADE MARK REGISTERED

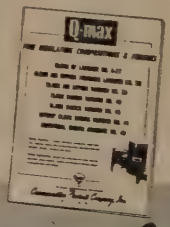
7 Service-Proven Types OF FINE Insulating Compositions and Finishes

- CLEAR RF LACQUER NO. A-27
- CLEAR AIR DRYING FINISHING LACQUER NO. 28
- BLACK AIR DRYING VARNISH NO. 30
- CLEAR BAKING VARNISH NO. 43
- BLACK BAKING VARNISH NO. 45
- HITEMP CLEAR BAKING VARNISH NO. 41
- INDUSTRIAL BAKING ADHESIVE NO. 49

Here's what Q-Max does:

Q-Max reduces corrosion, tropicalizes (when solutions permit the use of tropicalizing agents), repels moisture, increases volume and surface resistivity, promotes electrical stability, protects, reinforces and bonds. Q-Max has proven its worth in actual service under all climatic and operating conditions — the reason why radio engineers and operations men, everywhere, specify Q-Max for utmost protection.

These are its many applications: Q-Max, developed by C-P engineers to provide better performance for installations in RF service, is highly efficient when applied to a wide variety of materials and surfaces. Applications include the treatment of wood, steatite, porcelain, glass, plastics, organic and inorganic fabrics, paper, vulcanized fibre and metals. A reputation for positive action and permanence has made Q-Max the accepted standard for RF service.



WRITE FOR YOUR COPY OF THE NEW Q-MAX CATALOG

Q-MAX CHEMICALS DIVISION

Communication Products Company, Inc.

KEYPORT NEW JERSEY

SECTION MEETINGS

(Continued from page 38A)

"Electrical Application of Glass," by E. M. Guyer, Corning Glass Co.; "Standardization Program of the RTMA," by V. M. Graham, Sylvania Electric Products Inc.; August 19, 1950.

HOUSTON

"Some Problems in the Miniaturization of Components," by Leon Podolsky, Sprague Electric Company; May 16, 1950.

"The FM Logging System," by W. J. Greer, Halliburton Oil Well Cementing Company; June 21, 1950.

MONTREAL

Tour of Canadian Broadcasting Corporation Studio; Election of Officers; May 10, 1950.

NEW MEXICO

Election of Officers; June 23, 1950.

"Recent Applications of Electron Multiplier Tubes," by J. A. Allen; July 21, 1950.

SAN ANTONIO

"Ground Controlled Approach," by W. P. Lord, U. S. Air Force; "G. C. A. and the Berlin Air Lift," by J. R. Guthrie, U. S. Air Force; July 27, 1950.

SAN DIEGO

"Network Analysis, Simplified," by D. C. Kalbfell, Faculty, San Diego State College; August 1, 1950.

TOLEDO

"Control Problems of Atomic Power Generators," by M. A. Schultz, Westinghouse Corporation; June 20, 1950.

MEMBERSHIP

The following transfers and admissions were approved and will be effective as of October 1, 1950:

Transfer to Senior Member

Bibbero, R. J., 773 Potomac Ave., Buffalo 9, N. Y.
Braun, W. L., 555 Long Ave., Harrisonburg, Va.
Denius, H. R., Woodbridge, Va.
Doersam, P. D., Research & Development Laboratories, Hughes Aircraft Co., Culver City, Calif.
Dwork, L. E., 125 E. Clinton Ave., Bergenfield, N. J.
Fisk, N. C., 3005 W. Chicago, Detroit 6, Mich.
Gerlach, A. A., 4020 Overhill Ave., Chicago 34, Ill.
Hamilton, G. E., 37 Weston St., Nutley, N. J.
Haner, L. P., 75 Koenig Rd., Tonawanda, N. Y.
Horrell, M. W., 4855 Fourth Ave., Detroit 1, Mich.
Jenkins, J., 7209 Fait Ave., Baltimore 24, Md.
Levens, L. M., 2000 Anthony Ave., New York 57, N. Y.
Morrison, L. H., 134 Upland Rd., Waban 68, Mass.
Robinson, E. F. V., Radio and Electrical Engineering, National Research Council, Ottawa, Ont., Canada
Skellett, A. M., 10 Midwood Ter., Madison, N. J.
Sperling, P., 4501-B Ridgeway Dr., Los Alamos, N. Mex.
Wallace, F. C., 260 Linden Ave., Belleville 9, N. J.
Zaret, M. E., 15 Cedar St., Nutley, N. J.

Admission to Senior Member

Curry, G. T., 618 Maple, Emporium, Pa.

(Continued on page 42A)

STANDARD RI-FI* METERS

14kc to 1000mc!

DEVELOPED BY **STODDART** FOR THE ARMED FORCES.

AVAILABLE COMMERCIALLY.

VHF!
15 MC to 400 MC
NMA - 5

Commercial equivalent of TS-587/U.
Sensitivity as two-terminal voltmeter, (95 ohms balanced) 2 microvolts 15-125 MC; 5 microvolts 88-400 MC. Field intensity measurements using calibrated dipole. Frequency range includes FM and TV Bands.

VLF!
14 KC to 250 KC
NM - 10A

Commercial equivalent of AN/URM-6.
A new achievement in sensitivity! Field intensity measurements, 1 microvolt-per-meter using rod; 10 microvolts-per-meter using shielded directive loop. As two-terminal voltmeter, 1 microvolt.

HF!
150 KC to 25 MC
NM - 20A

Commercial equivalent of AN/PRM-1.
Self-contained batteries. A.C. supply optional. Sensitivity as two-terminal voltmeter, 1 microvolt. Field intensity with ½ meter rod antenna, 2 microvolts-per-meter; rotatable loop supplied. Includes standard broadcast band, radio range, WWV, and communications frequencies.

UHF!
375 MC to 1000 MC
NM - 50A

Commercial equivalent of AN/URM-17.
Sensitivity as two-terminal voltmeter, (50-ohm coaxial input) 10 microvolts. Field intensity measurements using calibrated dipole. Frequency range includes Citizens Band and UHF color TV Band.

Since 1944 **Stoddart RI-FI*** instruments have established the standard for superior quality and unexcelled performance. These instruments fully comply with test equipment requirements of such radio interference specifications as JAN-I-225, ASA C63.2, 16E4(SHIPS), AN-I-24a, AN-I-42, AN-I-27a, AN-I-40 and others. Many of these specifications were written or revised to the standards of performance demonstrated in **Stoddart** equipment.

The **rugged** and **reliable** instruments illustrated above serve equally well in field or laboratory. Individually calibrated for consistent results using internal standard of reference. Meter scales marked in microvolts and DB above one microvolt. Function selector enables measurement of sinusoidal or complex waveforms, giving average, peak or quasi-peak values. Accessories provide means for measuring either conducted or radiated r.f. voltages. Graphic recorder available.

***Radio Interference and Field Intensity.**

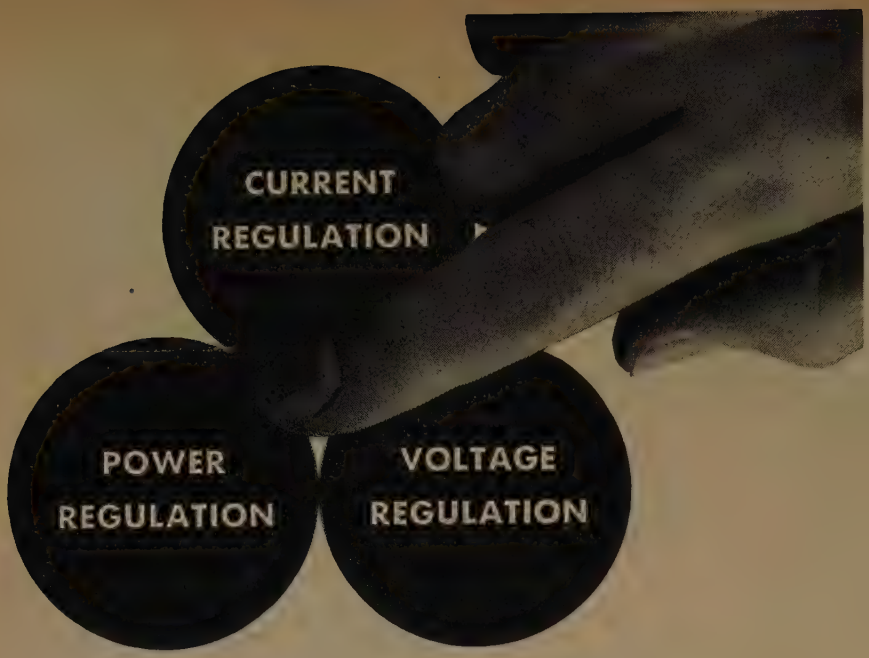
Precision Attenuation for UHF!

Less than 1.2 VSWR to 3000 MC.
Turret Attenuator:
0, 10, 20, 30, 40, 50 DB.
Accuracy ± .5 DB.

Patents applied for.

STODDART AIRCRAFT RADIO CO.

6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIF.
Hillside 9294



can you put your Finger on the TROUBLE?

If you can, a SORENSEN Electronically controlled, magnetic amplifier regulating circuit can solve it!

Sorensen's *new line* of Electronic AC Voltage Regulators is the *most accurate* and *most economical* line of Electronic Voltage Regulators on the market today. Standard specifications offer Accuracy to within ±0.1% and Distortion as low as 2%. Load range from zero to full load. All models are temperature Compensated and can be supplied hermetically sealed or fosterited. And the Sorensen line uses *less tubes* than other electronic type regulators.

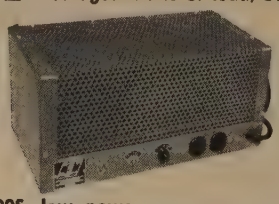
***Sorensen Engineers* are always at your service to solve unusual problems and give you the benefits of years of experience. Describe your needs and let a Sorensen Engineer suggest a solution. It will save you time and money to try Sorensen first.**

CATALOG A1049 DESCRIBES COMPLETE LINE

TYPICAL AC REGULATORS

Model 5000-2S—high power
Input 95 to 130; distortion 3%; load 0-5000 VA;
Accuracy ±0.1% against line or load; 50-60 cycles

Model 3000S—medium power
Input 95 to 130; distortion 3%; load 0-3000 VA;
Accuracy ±0.1% against line or load; 50-60 cycles



Model 500S—low power
Input 95 to 130; distortion 3%; load 0-500 VA;
Accuracy ±0.1% against line or load; 50-60 cycles

POWER controlled converted *Sorensen* **and company, inc.**
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

MEMBERSHIP

(Continued from page 40A)

Hayworth, D. F., 305 S. Blanchard Ave., Wheaton, Ill.
Maxwell, J. W., 1502 E. 80 St., Indianapolis, Ind.
Olsen, R. K., 8042 Brecksville Rd., Brecksville, Ohio
Safford, F. J., 6 Dougal Ave., Livingston, N. J.
Wooldridge, D. E., Research & Development Laboratories, Hughes Aircraft Co., Culver City, Calif.

Transfer to Member

Baruch, J. J., 1 Westgate, Cambridge, Mass.
Boyle, B. H., 6019 Primrose, Indianapolis 20, Ind.
Crandall, W. R., CNAAT (Staff), Bldg. 1, NAS, Corpus Christi, Tex.
Gangopadhya, I., c/o Area Installation Engineer, Eastern Court, New Delhi 1, India
Hughes, W. A., 2329 Thayer St., Evanston, Ill.
Neely, N. B., 7422 Melrose Ave., Los Angeles 46, Calif.
Packard, R. H., 14 Gleason Rd., Lexington 73, Mass.
Parker, H. W., Box 575, Oxnard, Calif.
Phlegar, C. L., Jr., Radio Station WHBU, 640 Citizens Bank Bldg., Anderson, Ind.
Price, G. W., 226 Park Ct., S.E., Cedar Rapids, Iowa
Stubbins, W. F., 1582 Glen Parker Ave., Cincinnati 23, Ohio
Vergason, D. L., Sylvania Electric Products Inc., Emporium, Pa.
Wight, V. H., 1411 Nemaha, Lincoln 2, Neb.

Admission to Member

Albrecht, J. C., 1612 Saunders, St. Paul 5, Minn.
Bakura, J., 65 Edward Rd., Watertown, Mass.
Ball, R. M., Jr., c/o Mehrabad Airport, Department Civil Aviation, Teheran, Iran
Basil, V. P., D-6, Airport Lane, Willingdon Aerodrome, New Delhi, India
Beckers, A. E., 447 Prospect St., Apt. 28 East Orange, N. J.
Disser, C. J., Suite 302, 1425 La Salle Avenue, S., Minneapolis 3, Minn.
Hyden, I. F., 3637 Hillcrest Dr., Los Angeles 16, Calif.
Kersey, L. R., Department of Electrical Engineering, University of British Columbia, Vancouver, B. C., Canada
Larkin, J. P., 208 E. 18 St., New York 3, N. Y.
Lac, C. B., 202 Carolina Pl., North Charleston, S. C.
McCready, K. F., General Electric Co., Receiving Tube Division, Owensboro, Ky.
Soderstrom, H. W., 3009 Cottage Grove Ave., S.E., Cedar Rapids, Iowa
Patremio, S. R., 253 Azalea Dr., New Milford, N. J.
Stacy, R. A., 3142 Werk Rd., Apt. 2, Cincinnati 11, Ohio
Tourville, G. A., 2315 Anniels Dr., Dallas 11, Tex.
Walrabenstein, E. M., Boeing Airplane Co., Seattle Wash.
Wolfe, B., 3513 Lucille Ave., Baltimore 15, Md.

The following elections to Associate grade were approved and will be effective as of September 1, 1950:

Apgar, R. R., Jr., 3 Maple Ter., Charleston 1, W. Va.
Bleasdale, J., 118 Blackburn Rd., Acorington, Lancs., England
Bloyd, J. E., 1630 Lauderdale Ave., Lakewood, Ohio
Burkhalter, B. L., Jr., 1841 N. Prospect Ave., Milwaukee 2, Wis.
Cohen, B. E., 2700 Hazelwood, Detroit 6, Mich.
Collins, J. D., 1323 Ave. D, Beaumont, Tex.

(Continued on page 44A)

NOTICE to MYCALEX USERS

and all recipients of the 1950 IRE DIRECTORY

The complete Mycalex 1950-51 Catalog-Engineer's Handbook is bound in your new IRE DIRECTORY. It contains complete characteristics of all types of Mycalex glass-bonded mica, information concerning comparative properties of various dielectrics, the proper design criteria for molded and machined insulators, and a great deal of other engineering data which will prove most useful in solving your insulation problems.

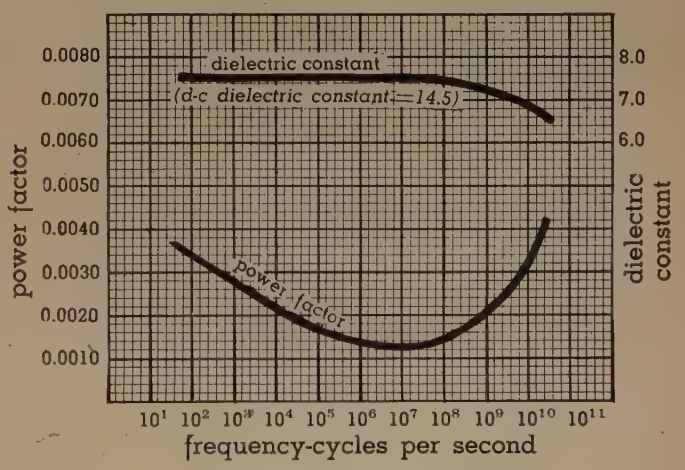
An error was made in reproducing the graph on the bottom of page 15 in the Mycalex Catalog-Engineer's Handbook (which appears in alphabetical order in the Product Directory Section of the IRE Yearbook). Below is the corrected graph and it is suggested that you cut it out as indicated and paste, or affix it with scotch tape, over the graph now shown at the bottom of page 15 of the Catalog.

Mycalex 400 is a grade L-4A insulation in accordance with JAN-I-10. It has a power factor at 1 meg. of 0.0018 and loss factor of only 0.013 at 1 meg. after 48 hours emersion in water.

Our application Engineering Dept. is at your disposal to help you solve your insulation engineering problems.

Additional copies of the Mycalex 1950-51 Catalog-Engineer's Handbook are available on request.

Mycalex 400 — variation of power factor and dielectric constant with frequency



CUT ON DOTTED LINE AND INSERT ON PAGE 15 OF CATALOG

SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG. U.S. PAT. OFF.

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y. Plant and General Offices: Clifton, N. J.

MORE GEO. STEVENS COIL WINDING EQUIPMENT IS IN USE THAN ALL OTHER MAKES COMBINED!

• **MORE OUTPUT . . . LOWER COSTS . . .** from *EXCLUSIVE* SPEED FEATURE. Universal motors permit variable speeds without changing belts and pulleys. Coil design permitting, speeds as high as 7500 RPM are not uncommon.

• **PORTABILITY.** Conveniently carried from place to place. Machines come mounted on bases to constitute one complete unit.

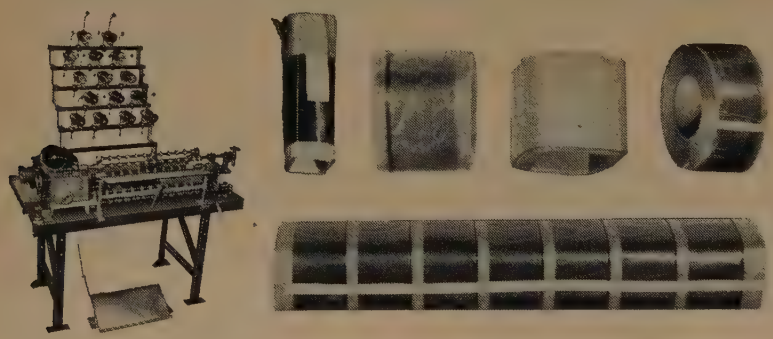
• **MUCH LOWER ORIGINAL COST.** The same investment buys more GEO. STEVENS machines than any other coil winding machines.

• **LONG LIFE.** Most of the original GEO. STEVENS machines bought 14 years ago are still operating daily at full capacity.

• **MUCH FASTER CHANGING OF SET-UPS** than any other general purpose coil winding machine. Quickly changed gears and cams save time between jobs.

• **VERY LOW MAINTENANCE.** Replacement parts are inexpensive, can be replaced in minutes, and are stocked for "same day" shipment, thus saving valuable production time.

• **EASIEST TO OPERATE.** In one hour, any girl can learn to operate a GEO. STEVENS machine.



Transformer winder Model 37S multiple winds power, audio, automotive, fluorescent ballast and similar types of coils. Winds wire from No. 18 B&S to 46 B&S up to 9" O.D. Maximum economy is possible by using mandrels up to 30" long. Thirty or more coils may be wound at one time. All turns are accurately registered by Model 50 or 51 6" full vision clock face Dial Counter. Set-ups can be changed in less than 5 minutes. A gear chart is furnished to quickly determine wire spacing.

No loss of turns (an exclusive feature) and accurate margins are assured by a screw feed traverse and an electrically controlled clutch. Highly polished wire guide rollers are ball-bearing mounted for free running. Traverse is quickly adjusted from 1/16" to 6".

Paper feed:—A tilting table for pre-cut paper is furnished making paper feed simple and fast, or a new roll paper feed for extra economy is available at a small additional cost.

Motor equipment:—Variable speed, uniform torque ½ H.P. motor with foot treadle control.

Tension equipment:—12 T-1 tensions and spool rack. Tensions will handle 6" spools.

Mounting:—Ground steel channel base ensures rigidity and permanent alignment. Machine is shipped mounted on bench ready for use.

There is a GEO. STEVENS machine for every coil winding need. Machines that wind ANY kind of coil are available for laboratory or production line. . . . Send in a sample of your coil or a print to determine which model best fits your needs. Special designs can be made for special applications. Write for further information today.

World's Largest Manufacturer of Coil Winding Machines

REPRESENTATIVES

Frank Tatro
6022 No. Rogers Ave., Chicago 30, Illinois
Ralph K. Reid
1911 W. 9th St., Los Angeles 6, California
R. F. Staff & Co.
1213 W. 3rd St., Cleveland 13, Ohio

GEO. STEVENS
MFG. CO., INC.
Pulaski Road at Peterson
Chicago 30, Illinois

MEMBERSHIP

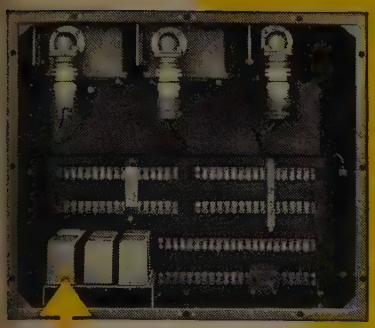
(Continued from page 42A)

Coombs, S. H., 76 Mountain Ave., Maplewood, N. J.
Cope, J. L., 408 Maple St., Yankton, S. Dak.
Crenca, G., 4117 Illinois Ave., N.W., Washington, D. C.
Crozier, R. W., 17139 Chatfield Ave., Cleveland 11, Ohio
Culicetto, P. J., 417 Bement Ave., S. I. 10, N. Y.
Davis, R. J., 4911 S.W. Charming Way, Portland, Ore.
Digrindakis, J., 526 West Ave., Bridgeport 4, Conn.
Fine, H., 86 Forrester St., S.W., Washington, D. C.
Fournier, L. W., 139-A Hornet, China Lake, Calif.
Gagne, F. W., 830½ S. Front St., Sunbury, Pa.
Gawel, E. W., 8220 Brandon Ave., Chicago 17, Ill.
Gleason, M. H., 1094 85 St., Niagara Falls, N. Y.
Gouin, P. L., Weston College, Weston 93, Mass.
Grauberger, W. E., 3570 W. 46 St., Cleveland 2, Ohio
Hannan, C. V., III, 102 Richards Rd., Rm. 205, Kansas City, Mo.
Harris, J. E., Jr., c/o Melpar, Inc., 452 Swann Ave., Alexandria, Va.
Huffman, J. C., 2513 Miller Park Cir., Winston-Salem, N. C.
Johnston, R. H., Radio Station WILL, University of Illinois, Urbana, Ill.
Kemic, C. S., Setauket Ave., E. Setauket, L. I., N. Y.
Kissinger, R. G., 4206 W. Adams St., Chicago 24, Ill.
Kuzma, P., Jr., 4632 N. Winchester St., Chicago 40, Ill.
Lauffenburger, H. A., 269 Douglas Ave., Elgin, Ill.
Levinson, S., 2969 Upton St., N.W., Washington, D. C.
Lima, E. J. T., 2603 Westwood Dr., Waynesdale, Fort Wayne 6, Ind.
Lincoln, J. P., 926½ E. Commerce St., San Antonio 3, Tex.
Lockwood, G. C., 37 S. Jersey St., Dayton 3, Ohio
Lucero, W. H., 71 Rest Beach, Key West, Fla.
Madrick, S. A., 76-20 271 St., New Hyde Park, N. Y.
Magdeburger, P. E., 40 Newman Ave., Nutley 10, N. J.
McCallum, C. A., Rawson 2682, Olivos FCNGBM, Buenos Aires, Argentina
Mitchell, P. R., 320 W. Montecito Dr., El Monte, Calif.
Nelson, J. B., 29 West 39 St., Anderson, Ind.
Nelson, V. A., 737 South Lyman, Oak Park, Ill.
Paracchini, G. B., c/o Mr. Berizzi, 607 Fifth Ave., New York, N. Y.
Preisig, J. O., 1625 Overing St., New York, N. Y.
Reynolds, B. G., 2200 Nichol Ave., Anderson, Ind.
Schlaepfer, E. D., Box 2902, Rio De Janeiro, Brazil
St. Villers, D. R., 4316 Greenlee Ave., St. Bernard 17, Ohio
Stanley, E. R., 1138 Wadsworth St., Syracuse, N. Y.
Subrahmanyam, T., Delhi Zone Transmitters, Civil Lines 2, Delhi, India
Tarowsky, H., 45 E. Mosholu Pkwy., Bronx 67, N. Y.
Thayer, J. W., 4553 West 150 St., Cleveland 11, Ohio
Thompson, M. A., 2610 San Jacinto, Beaumont, Tex.
Van S. Bennett, J. H., Box 376, Mt. Pleasant, S. C.
Von Ohlsen, L. H., Jr., 3035 Greenleaf St., Allentown, Pa.
von Trentini, G., 1790 Calle Rosetti, Fla. FCNGBM, Buenos Aires, Argentina
Walling, K. L., 4537 S.E. 46 Ave., Portland 6, Ore.
Whitman, J. A., 23 Hillside Ave., Melrose 76, Mass.
Wilkins, F. W., 2 Arlington Park, Buffalo 1, N. Y.
Wilkinson, J. E., 1830 S. 54 Ave., Chicago, Ill.
Wilson, R. M., 174 James Ave., Oxnard, Calif.
Wilson, V. C., 7034 South Park Ave., Chicago, Ill.
Wopat, J. W., Jr., 88 West 197 St., New York 63, N. Y.
Yates, T., 701 N. Colorado St., Midland, Tex.

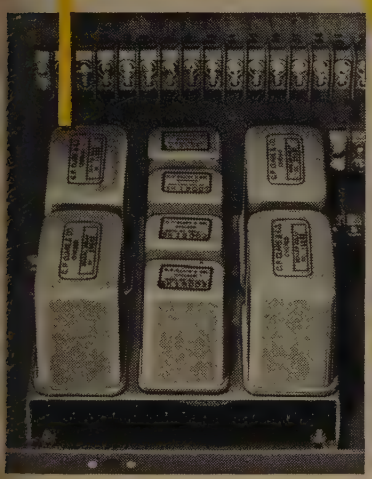
Airborne Instruments Laboratory *Specifies*

CLARE SEALED RELAYS

For Aircraft, Ship and Submarine Control Equipment



Front view of Airborne Instruments Laboratory control panel, with cover removed, showing group of eight CLARE hermetically sealed relays which perform important circuit control functions.



Close-up view of the CLARE relay installation which demonstrates the economical use of space which use of CLARE sealed relays makes possible.

Cutaway view of typical CLARE Type "K" d-c Relay which is hermetically sealed in a permanent atmosphere of dry, inert gas to give maximum performance under the most extreme conditions of dust, moisture, air pressure and combustible gases.

CLARE
Type "K" Hermetically Sealed Relay

Airborne Instruments Laboratory of Mineola, N. Y. uses CLARE Type "J" and Type "K" sealed relays as components of ruggedly designed but delicately operated control equipment for aircraft, ship and submarine.

These small, compact, space-saving relays are used in circuit applications that cover the broad field of low and high current, a-c and d-c switching and video switching. CLARE Type "J" and Type "K" Relays were selected for their outstanding speed of operation, dependable performance, resistance to vibration and very small size. Hermetically sealed in dry, inert gas, they are immune to changes in atmospheric pressure, humidity, dust or dirt . . . will operate as required over a long period.

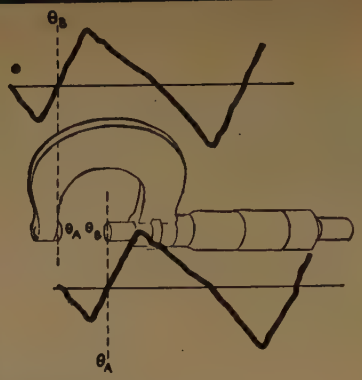
CLARE relays have long been first choice of manufacturers whose products must not fail. Selection of highest quality materials, precise manufacture and ability to "custom-build" just the relay for a specific requirement have made CLARE relays first choice with engineers who insist on . . . and get . . . the best.

Sales engineers are located in principal cities to cooperate with you in the development of a CLARE "custom-built" relay that will meet your most difficult relay need. Look in your classified telephone directory or write: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable Address: CLARELAY.

CLARE RELAYS . . .

First in the Industrial Field

save work . . .
increase
precision . . .



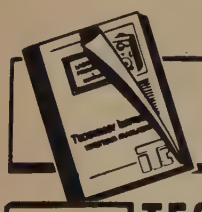
measure
phase difference
DIRECTLY

with the new TIC Phase Meter

TIC's New 320-A Phase Meter is the first commercially available instrument for the direct measurement of the phase difference between two recurrent mechanical motions or two electrical signals independent of amplitude, frequency, and wave shape.

Phase measurements are made instantly and accurately—no balances, adjustments or corrections are involved. Phase angle readings at audio and ultrasonic frequencies are indicated directly on a large wide-scale meter with ranges of 360°, 180°, 90° and 36°. Useful frequency range 2 cps. to 100 k.c.

In audio facilities, ultrasonics, servomechanisms, geophysics, vibration, acoustics, aerial navigation, electric power transformation or signaling . . . in mechanical applications such as printing register, torque measurement, dynamic balancing, textile and packaging machinery and other uses where an accurate measure of the relative position of moving parts is required . . . the Phase Meter is a long needed measuring instrument never before available — a new tool for a heretofore neglected field of measurement.



Technical Catalog — yours for the asking. Contains detailed information on all TIC Instruments, Potentiometers and other equipment. Get your copy without obligation — write today.

TECHNOLOGY INSTRUMENT CORP.
1058 Main Street, Waltham 54, Massachusetts
Engineering Representatives Cleveland, Ohio PRospect 1-6171
Chicago, Ill.—UPtown 8-1141 Dallas, Tex.—LOgan 6-5097 Rochester, N.Y.—Charlotte 3193-J
Cambridge, Mass.-ELiot 4-1751 Canaan, Conn.-Canaan 649 Hollywood, Cal.-HOllywood 9-6305

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Octal Base Connector With Built-in Resistor

Designed for use with a 6AL7-GT electron-ray tuning indicator tube, a new octal base connector with an insulated, built-in resistor is announced by **Alden Products Co.**, 117 N. Main St., Brockton 64, Mass.

Ready for immediate connection, the 208FERC, with a fully insulated, 3,300-ohm resistor built in the molding and complete with leads, enables television manufacturers to incorporate a 6AL7-GT tuning indicator tube in their set design, and thus obtain precision tuning for optimum audio quality at a minimum effort and cost.

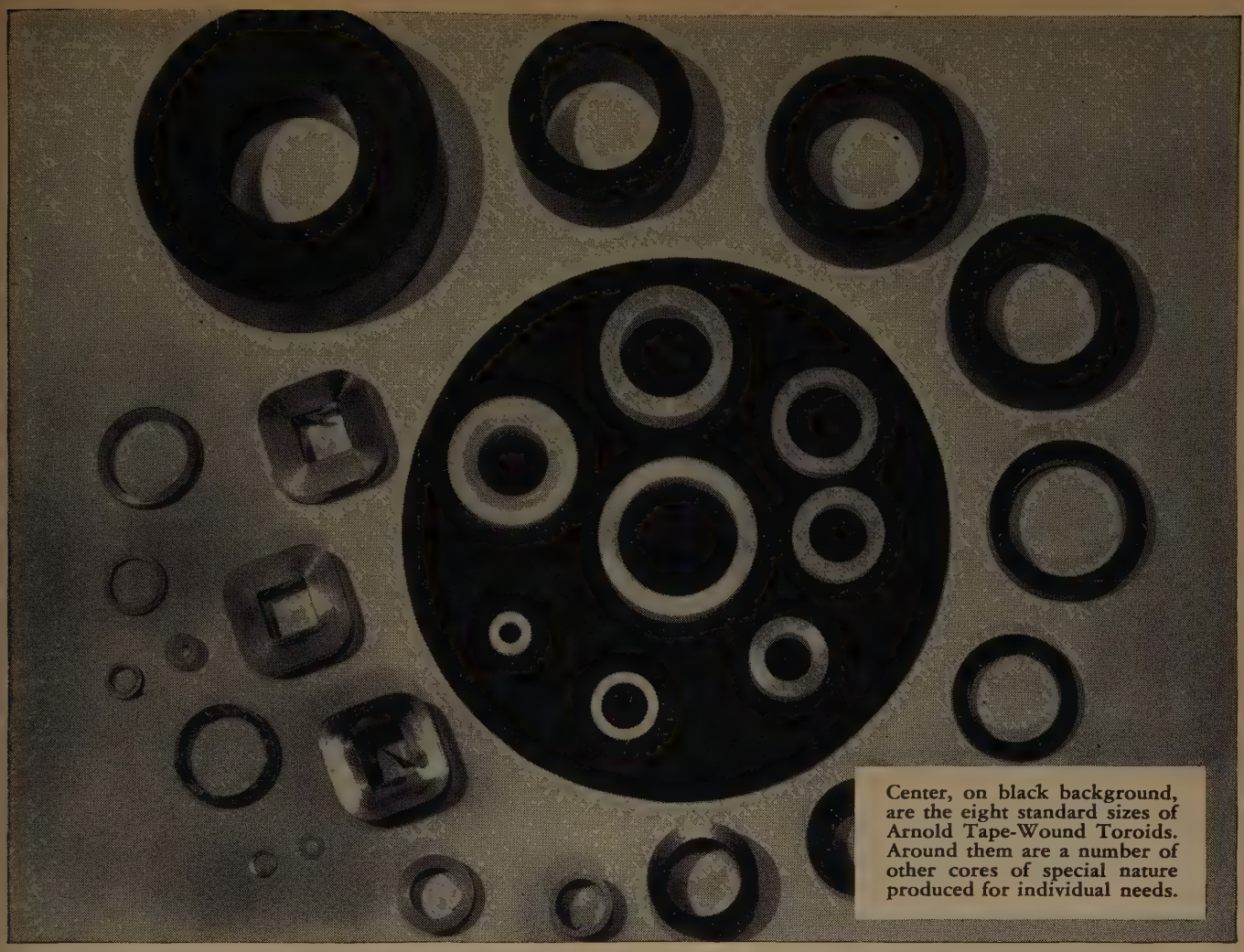
Available in production quantities, the connector can be supplied with either 5 or 6 leads to any length as specified ready for internal connections.

TV Sweep Generator

The **Kay Electric Co.**, 24 Maple Ave., Pine Brook, N. J., announces the Switcha-Sweep, an entirely new all-electronic TV sweep generator with fundamental outputs on all channels, as well as output in the if range. A rotary switch selects the desired channel, which is swept through a range of 15 Mc by an all-electronic system. The instrument also produces a true zero level reference baseline on the oscilloscope display.

Sawtooth sweep eliminates phasing problems. Amplitude modulation of the sweep signal is less than 1 per cent per Mc. Both switched and continuously variable output attenuation is provided, with maximum outputs of about 0.5 volt on the 70-ohm unbalanced output and 1.0 volt on the 300-ohm balanced output. The Switcha-Sweep contains no internal marks, and is intended for use with external marker generators such as the Kay Megaligner, Mega-Marker, etc. A regulated power supply is provided to allow operation of the instrument under very poor power line condition. The many features of this instrument contribute to reduced costs of operation and maintenance, as compared to the more conventional mechanically-driven sweep generators.

(Continued on page 48A)



Center, on black background, are the eight standard sizes of Arnold Tape-Wound Toroids. Around them are a number of other cores of special nature produced for individual needs.

ARNOLD TAPE-WOUND TOROIDAL CORES

of DELTAMAX 4-79 MO-PERMALLOY SUPERMALLOY*

APPLICATIONS

MAGNETIC AMPLIFIERS
PULSE TRANSFORMERS
NON-LINEAR RETARD COILS and TRANSFORMERS
PEAKING STRIPS, and many other specialized applications.

RANGE OF SIZES

Arnold Tape-Wound Toroids are available in eight sizes of standard cores—all furnished encased in molded nylon containers, and ranging in size from ½" to 2½" I.D., ¾" to 3" O.D., and ⅛" to ½" high.

RANGE OF TYPES

These standard core sizes are available in each of the three magnetic materials named, made from either .004", .002" or .001" tape, as required.

In addition to the standard toroids described at left, Arnold Tape-Wound Cores are available in special sizes manufactured to meet your requirements—toroidal, rectangular or square. Toroidal cores are supplied in protective cases.

**Manufactured under licensing arrangements with Western Electric Company.*

W&D 3182

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

Magnecorder and amplifier in rack mount

Magnecorders are portable, perfect for remotes.

THE FIRST CHOICE OF RADIO ENGINEERS

HIGH FIDELITY, LOW COST

Only Magnecord offers you such high fidelity at such low cost. Magnecorder frequency response: 50-15 kc ± 2 db. Signal-noise ratio: 50 db. Harmonic distortion less than 2%. Meets N.A.B. standards. More radio engineers use Magnecorders than all other professional tape recorders combined!

GREATEST FLEXIBILITY

Mount a Magnecorder in a rack or console cabinet for delayed studio or network shows. Slip it into its really *portable* cases for remotes.

Add to your Magnecord equipment as you need it — combine and carry Magnecorders to suit every purpose.

MORE FEATURES

Your Magnecorder, new or old, now can have 3 heads (separate erase, record, and playback) to permit monitoring from tape. Three speeds (15"-7½"-3-¾" — up to an hour on a 7" reel) available on both PT6 and PT63 equipment. Dual track heads also available if desired.

MAGNECORDER

For every purpose . . . every purse!

PT6 SERIES
Most widely used professional tape recorder in the world.

PT63 SERIES
Three heads to erase, record, and monitor from the tape.

PT7 SERIES
A complete console for only $950.00. Outstanding features and flexibility. Models for portable or rack mount also available.

Write for NEW CATALOG

MAGNECORD, Inc., Dept. P. 10.
360 N. Michigan Ave., Chicago 1, Ill.
Send me latest catalog of Magnecord equipment

Name.....

Company.....

Address.....

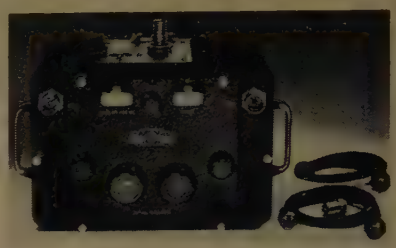
City..... .....Zone.....State.....

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 47A)

VHF Impedance Bridge



General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., announces the Type 1601-A VHF bridge which extends the frequency range of conventional bridge techniques up to 165 Mc. Similar in basic circuit to the GR Type 916-A rf bridge, in wide use at lower frequencies, the new instrument measures the impedance of antennas, lines, networks, and components between the frequencies of 10 and 165 Mc. Over-all accuracy is ±2 per cent for resistance and ±5 per cent for reactance. Terminals are GR Type 874 coaxial connectors.

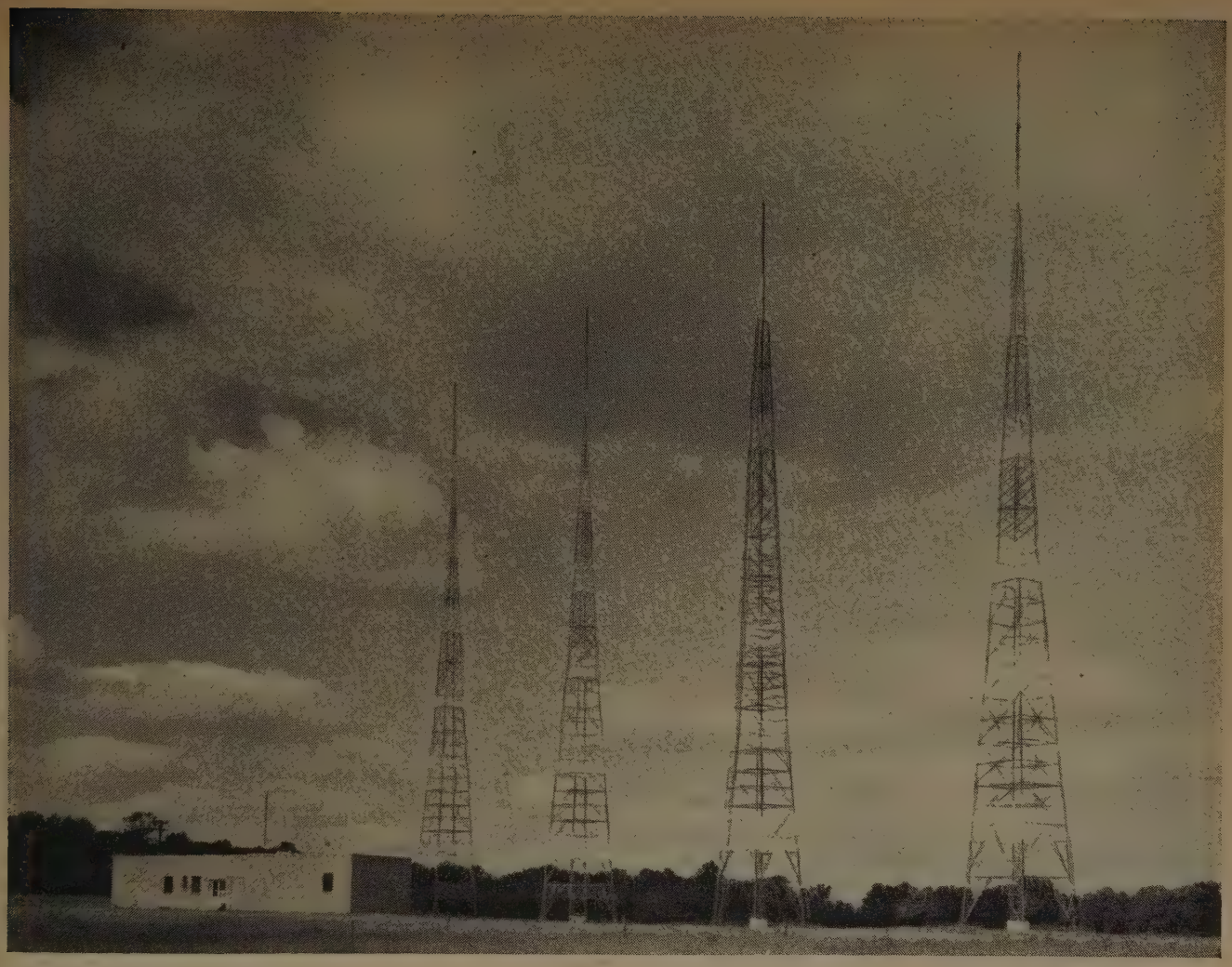
Derivative-Integral Servo Design Filter

A new test instrument for the servomechanisms field has been recently announced by the **Krohn-Hite Instrument Co.,** 580 Massachusetts Ave., Cambridge 39, Mass.

The Model 340-A derivative-integral servo design filter is designed primarily to aid the servo engineer in experimental determination of optimum filter characteristics for any feedback control system.

When used in the dc path of a servo loop, the Model 340-A represents a compensating function which approximates either proportional-plus-derivative or proportional-plus-integral correction. Mathematically, the compensating function is the ratio of two first-order polynomials. By means of the frequency and attenuation controls the filter may be adjusted for operation anywhere in the frequency range between 0.01 to 100 cps, with attenuation ratios ranging between 2 and 50. Both attenuation ratio and frequency are read directly on the two dials provided. A switch selects between the two types of compensation available.

(Continued on page 62A)



IT'S ALL THERE!

You can't see Blaw-Knox engineering—*but it's there!* You can't see Blaw-Knox experience in tower-building—*but it's there.* You can't see efficiency and strength and durability—but they're all there—when the towers are built by Blaw-Knox.

. . . A quotation will prove that there's no premium on Blaw-Knox quality.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2037 Farmers Bank Building, Pittsburgh, Pa.

Distributed by GraybaR
OFFICES IN 100 PRINCIPAL CITIES

BLAW-KNOX ANTENNA TOWERS

WANTED:
SENIOR PROJECT ENGINEER

FOR RESPONSIBLE POSITIONS IN DEVELOPMENT OF

COMMUNICATIONS & NAVIGATION ELECTRONIC SYSTEMS

- Graduate or practical engineer.
- 5 or 6 years experience in development of electronic systems.
- Direct own project and supervise engineering personnel.

If you can qualify, send us a resume of your education, experience, age and salary requirements.

Or, if you prefer, telephone us for an appointment . . . Matawan 1-2600.

Lavoie Laboratories, Inc.

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

ELECTRONIC ENGINEERS

BENDIX RADIO DIVISION

Bendix Aviation Corporation

PRODUCTION DESIGN RESEARCH

Bendix Radio Division, a leader in the field of high quality radar and communications equipment, has positions for engineers experienced in the design and development, for production, of radio and radar equipment or electronic research.

Positions are available at all salary levels.

Good advancement opportunities, air-conditioned plant in suburban location, excellently equipped laboratories, technical library, large experimental engineering model shop.

Housing and rentals in Baltimore are plentiful.

Interviews will be held in Baltimore, Chicago and New York. Please send resume of experience promptly to:

MR. W. L. WEBB, *Director* Engineering and Research

BENDIX RADIO DIVISION

Bendix Aviation Corporation • Baltimore 4, Maryland

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. . . . .

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

PROJECT RADIO ENGINEER

To take responsible charge of design of radio communications systems between Hawaiian Islands. Experience in VHF and microwave links design desirable. College training or equivalent necessary. Live in Honolulu. Contact Mutual Telephone Co. Box 2200, Honolulu, T. H.

ENGINEER

Chief systems test engineer with practical experience in electro-mechanical and hydraulic systems to direct systems testing on guided missiles. Familiarity with production testing techniques and test equipment in above fields is desirable. Excellent opportunity for someone who can organize a rapidly expanding facility. Direct inquiries to Manager, Engineering Personnel, Bell Aircraft Corp., P. O. Box 1, Buffalo, New York.

SPECIFICATION WRITERS

Specification writers capable of clear, concise technical description of the design, construction and testing of missile and electronic equipment. Knowledge of military specifications and familiarity with aircraft and electronic components is essential. Direct inquiries to Manager, Engineering Personnel, Bell Aircraft Corporation, P. O. Box 1, Buffalo 5, New York.

ENGINEER

Engineer, electrolytic capacitor, at least 5 years experience in design and development. Write resume of experience and salary expected. Box 620.

RADIO ENGINEER

Radio engineer wanted by prominent Chicago manufacturer to design and supervise manufacture of full line of commercial amplifiers. Must have engineering degree or equivalent and minimum of 2 years design experience in commercial P.A. systems. Give details including age, education, experience, reference, availability and salary expected. Box 621.

ENGINEER

Excellent opportunity for engineer to apply microwave measurements and techniques to development and manufacture of magnetrons and klystrons. Pulse circuit knowledge also valuable. B.S. degree and experience or advanced degree with heavy concentration on above required. State salary expected and qualifications. Location New York City. Box 622.

CIRCUITS ENGINEER

Rapidly expanding company in instrumentation field has opening for senior en-

(Continued on page 51A)

Graduate ENGINEERS

Good Opportunities for ELECTRONICS

Engineers or Physicists

M.S. or Ph.D. in Physics, Physical Chemistry, E.E., M.E., or Ch.E. for industrial electronics research. Must be outstanding technically with at least a few years research experience, and interested in the development of instruments and physical techniques.

Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific.

All inquiries will be considered promptly and kept confidential.

E. I. du Pont de Nemours & Co. (Inc.)
Engineering Department Personnel
Wilmington 98, Delaware

ELECTRONIC ENGINEERS

Excellent opportunities are offered by one of the leading concerns in the electronic computer field to engineers with development or design experience in video and pulse circuitry or test and maintenance experience in the radar, television, or computer fields.

Send complete resumes and salary requirements to:

•

Personnel Department
ECKERT-MAUCHLY COMPUTER CORPORATION
3747 Ridge Avenue
Philadelphia 32, Pa.
Subsidiary of Remington Rand, Inc.

POSITIONS OPEN

(Continued from page 50A)

gineer. Prefer man with masters degree and 4 or more years of experience in design of pulsing circuits, VHF and UHF. Excellent opportunity for man who can meet requirements. Location Brooklyn. Send complete resume to Box 623.

PHYSICIST

Physicist for fundamental electron tube research. Should be familiar with techniques of producing photo-electric, secondary emissive and fluorescent screens, experience with electron-optics, physical optics and solid state physics an advantage. Box 624.

SALESMAN

Salesman to organize and promote sales of high quality radio resistors now being produced by a company well established in radio and electrical component industry. Give summary of experience and availability in reply. Box 625.

ASSISANT PROFESSOR AND INSTRUCTOR

Strong eastern college has opening for Assistant Professor and Instructor in electrical engineering. Master of Science in electrical engineering is required, and industrial experience is desirable. Send resume of qualifications, references and salary required. Box 626.

PHYSICISTS AND ENGINEERS

Cornell Aeronautical Laboratory, an affiliate of Cornell University, has permanent positions open in fields of pure and applied physics for men of project engineer caliber with advanced degrees and experience in physics, applied mathematics, electronics, and mechanical instrument design. The position of our laboratory is between those of universities and commercial research institutes, and combines, we believe, many of the traditional advantages of both. Inquiries confidential; address Mr. Nathaniel Stimson, Dept. R, Cornell Aeronautical Lab. P. O. Box 235, Buffalo 21, New York.

ELECTRONIC PHYSICIST

Electronic physicist for research and development work on instrumentation problems with major petroleum refiner. Degree in physics essential, M.S. or Ph.D. preferred. Must have a minimum of 5 years' research experience on a variety of electronic problems and demonstrated ability to develop new and ingenious electronic devices. Age 28-40. Location Chicago. Salary dependent upon training and experience, Reply in confidence giving full details to Box 627.

ENGINEER

Well known German radio manufacturer has immediate opening for engineer with design and development experience in FM-TV equipment. Factory situated in mountainous part of southern Germany (U.S. zone) with pleasant living conditions (summer and winter sports). German language desirable. Please write to Z.G. 931-Annoncen-Expedition Carl Gabler, GMBH, Munich, Germany.

(Continued on page 52A)

ELECTRONICS TECHNICIANS WANTED

The RCA Service Company, Inc., a Radio Corporation of America subsidiary, needs qualified electronics technicians for U. S. and overseas assignments. Candidates must be of good character and qualified in the installation or maintenance of RADAR or COMMUNICATIONS equipment or TELEVISION receivers. No age limits, but must have at least three years of practical experience.

RCA Service Company offers comprehensive Company-paid hospitalization, accident and life insurance programs; paid vacations and holidays; periodic review for salary increases; and opportunity to obtain permanent position in our national and international service organization, engaged in the installation and maintenance of AM, FM, and TV transmitters, electronic inspection devices, electron microscopes, theatre and home television, r-f heating equipment, mobile and microwave communications systems, and similar electronic equipment.

Base pay, overseas bonus, payments for actual living and other expenses, and benefits mentioned above add up to $7,000 per year to start for overseas assignments, with period review of base salary thereafter. Openings also available at proportionately higher salaries for specially qualified technicians with supervisory ability.

Qualified technicians seeking an advantageous connection with a well-established company, having a broad-based, permanent peacetime and wartime service program, write to:

Mr. G. H. Metz,
Personnel Manager,
RCA Service Company, Inc.,
Camden 2, New Jersey.

RESEARCH ENGINEERS ELECTRICAL ENGINEERS AND PHYSICISTS

THE FRANKLIN INSTITUTE LABORATORIES FOR RESEARCH AND DEVELOPMENT

Have opening for personnel with 2-10 years experience. Advanced degrees are desirable in certain of the positions. Fields of interest covered are: Mathematical Analysis of Physical Problems, Statistical Theory of Communications, Electromagnetic Theory, Circuit Analysis, Servomechanism Theory, Electrical Computing, Advanced and Fundamental Circuit Development, Radar and Pulse Circuits, Supervision of Operation of G.C.A. or Tracking Radar, Air Traffic Control, Air Navigation, Automatic Controls, Industrial or Marine Power Drives, and Electrical Machinery.

Send resume of education and experience, salary requirements and a photograph to:

Personnel Department
THE FRANKLIN INSTITUTE
Philadelphia 3, Pennsylvania

★ important personal and professional opportunities for experienced ELECTRONICS ENGINEERS

A broad program of research, design and development in new electronic fields with vast commercial applications by the manufacturer of Freed-Eisemann radio phonographs and television receivers provides an opportunity for gaining valuable experience in new electronic concepts and techniques under the direction of scientists of international repute. Adequate facilities, pleasant conditions and attractive salaries make this an opportunity for personal as well as professional advancement. Many openings for experienced electronic engineers . . . including:

- *Project Physicist* for fundamental electron tube research. Ph.D. or M.S. degree and extensive technical experience in the field of photo-electric, secondary emission, solid state, electron and physical optics.
- *Senior Electronics Engineer and Juniors:* B.S. or M.S. degree. Three to five years experience in television, radar, and display circuits.
- *Project Engineer:* Capable of designing low-power transmitters and receivers, AM, FM and UHF.

Furnish complete resume of education and experience, salary required to Director of Research.

FREED RADIO CORPORATION
200 Hudson St. • New York 13, N.Y.

POSITIONS OPEN

(Continued from page 51A)

MANUFACTURER'S REPRESENTATIVE

Must be sales engineer. To handle growing line of electronic test instruments which now includes oscillators, DC amplifiers, transducers, electronic potentiometers, electronic DC and AC voltmeters, megohmeters, bridges and others. Some good territories are still open. Send qualifications to Southwestern Industrial Electronic Co., P. O. Box 13058, Houston 19, Texas.

PROJECT ENGINEERS

Five years or more experience in charge of design and development of radio and communication equipment. Must be a graduate of a credited engineering school. Well equipped laboratory in modern radio and television plant, with excellent opportunities for advancement. Send resume of qualifications to Mr. S. F. Cascio, Personnel Director, Hallicrafters Company, 4401 West Fifth Ave., Chicago 24, Illinois.

ENGINEERS

A very large vacuum tube and cathode ray tube manufacturer has attractive openings for experienced vacuum tube engineers. It will be to your benefit to investigate these possibilities. Please write to Box 628.

(Continued on page 54A)

ENGINEERING OPPORTUNITIES
MODERN LABORATORIES IN LOS ANGELES AREA

Unusual opportunity for Senior men with degree and a background of proven accomplishment.

ELECTRONIC ENGINEERS
PHYSICISTS-CIRCUITRY
PHYSICISTS-ANALYSIS
PHYSICISTS-OPTICS
SERVOMECHANISMS ENGINEERS
ELECTRO MECHANICAL DESIGNERS
MECHANICAL DESIGNERS

Long term program of research and development.
Please do not answer unless you meet the above requirements.

RESEARCH AND DEVELOPMENT LABORATORIES
Hughes Aircraft Company
CULVER CITY, CALIFORNIA

Engineers—Physicists

- *What do you want in a position?*
- *What are your aims and ambitions?*

SENIORS

The W. L. Maxson Corporation offers special opportunities if you are heavily experienced in research and development on radar, computers and associated equipment.

Please address your job requirements and résumé to A. Hoffsommer for individual attention.

THE W. L. MAXSON CORPORATION
460 W. 34th Street New York 1, N.Y.

SENIOR ELECTRONIC ENGINEERS

Prominent New England Company needs a number of top-flight engineers, skilled on pulse circuits, microwave circuits, R. F. techniques and design and development of circuits for use in high speed electronic digital computers. Minimum of at least 6 to 8 years experience. Attractive salary—group insurance—pension plan—paid vacation. Please write, giving complete resume of education, experience and salary expected.

Box 629

The Institute of Radio Engineers, Inc.
1 East 79th Street, New York 21, N.Y.

Controlling the Nation's TV AND RADIO!

Clarostat supplies more controls for TV than any other manufacturer. Three decades of pioneering and specialization are duly recognized. And Clarostat's new plant with unexcelled mechanization and smoothest production flow, turns out over 50,000 controls a day, not to mention resistors of many different types, in meeting the major portion of today's TV and radio requirements. Obviously, for quality, uniformity, dependability, economy, it's CLAROSTAT.

Write for Engineering Bulletins on resistors, controls and resistance devices. Let us collaborate on your control and resistance problems and needs.

CLAROSTAT

Controls and Resistors

CLAROSTAT MFG. CO., INC. • DOVER, NEW HAMPSHIRE
IN CANADA: CANADIAN MARCONI CO. LTD., MONTREAL, P. Q., AND BRANCHES

PHYSICISTS AND ENGINEERS

You can find plenty of positions where you will work on minor improvements on radar, telemetering systems, and other conventional devices. However, you will find very few positions where you can break ground in new fields having tremendous significance. This you can do at the JACOBS INSTRUMENT COMPANY, whose entire effort is devoted to pioneering activities in new fields that it has opened up itself. One of these fields, for example, is that of ultra-high speed, ultra-compact digital computers and controllers. This company's JAINCOMP family of computers dominates this field. Other equally important fields are being developed. Engineers and physicists with sound backgrounds and experience in the design of advanced electronic circuits or precision mechanical instruments may qualify, also individuals with good backgrounds in applied physics. A few openings exist for outstanding junior E. E.'s and physicists, also experienced technicians; applicants for these positions must apply in person.

JACOBS
INSTRUMENT CO.
4718 Bethesda Ave.
Bethesda 14, Maryland

Positions available for

SENIOR ELECTRONIC ENGINEERS

with

Development & Design Experience

in

MICROWAVE RECEIVERS
PULSED CIRCUITS
SONAR EQUIPMENTS
MICROWAVE COMMUNICATIONS SYSTEMS

Opportunity For Advancement Limited only by Individual Ability

Send complete Resume to:
Personnel Department

MELPAR, INC.
452 Swann Ave.
Alexandria, Virginia

POSITIONS OPEN

(Continued from page 52A)

SENIOR ELECTRONIC ENGINEER

Opportunity with manufacturer of electronic electro-mechanical and radiation Instruments. Requirements: 5 years experience in design and development of pulse circuits, computers, nuclear instrumentation or video circuits required. Manufacturing or production experience desirable. Send complete resumes and salary requirements to: Berkeley Scientific Company, P. O. Box 1826, Richmond, California.

PRODUCTION ENGINEER

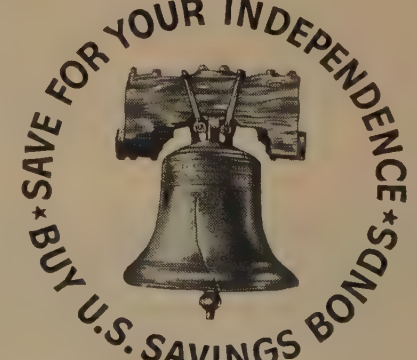
Opportunity with manufacturer of electronic, electro-mechanical and radiation instruments. Requirements: 5-10 years experience as electronic and mechanical instrument production engineer in small lot production. Thorough electronic theory grounding. Send complete resume and salary requirements to Berkeley Scientific Co., P. O. Box 1826, Richmond, California.

ELECTRICAL ENGINEER

Graduate with experience in design and product technique of specialized electronic tubes other than high production transmitting and receiving types. Bendix Aviation Corp., Kansas City Division, P.O. Box 1159, Kansas City, Missouri.

ELECTRONIC ENGINEERS

Excellent opportunities are offered by one of the leading concerns in the electronic computer field to engineers with development or design experience in video and pulse circuitry or test and maintenance experience in the radar television or computer fields. Send complete information to Personnel Department, Eckert-Mauchly Computer Corporation, 3747 Ridge Avenue, Philadelphia 32, Pa.



NATIONAL UNION RESEARCH DIVISION

Electrical Engineers and Physicists are needed for research on Cathode Ray, Subminiature, Secondary Emission and other types of Vacuum Tubes.

Permanent interesting positions are available in the following fields:

Tube design & development
Tube processing
High vacuum systems
Solid state physics
Electron optics
Phosphorescence

Men qualified in any of the above are invited to send their resumes to:

Divisional Personnel Manager
National Union Research Division
350 Scotland Rd., Orange, N.J.

PHYSICISTS AND SENIOR RESEARCH ENGINEERS

POSITIONS NOW OPEN

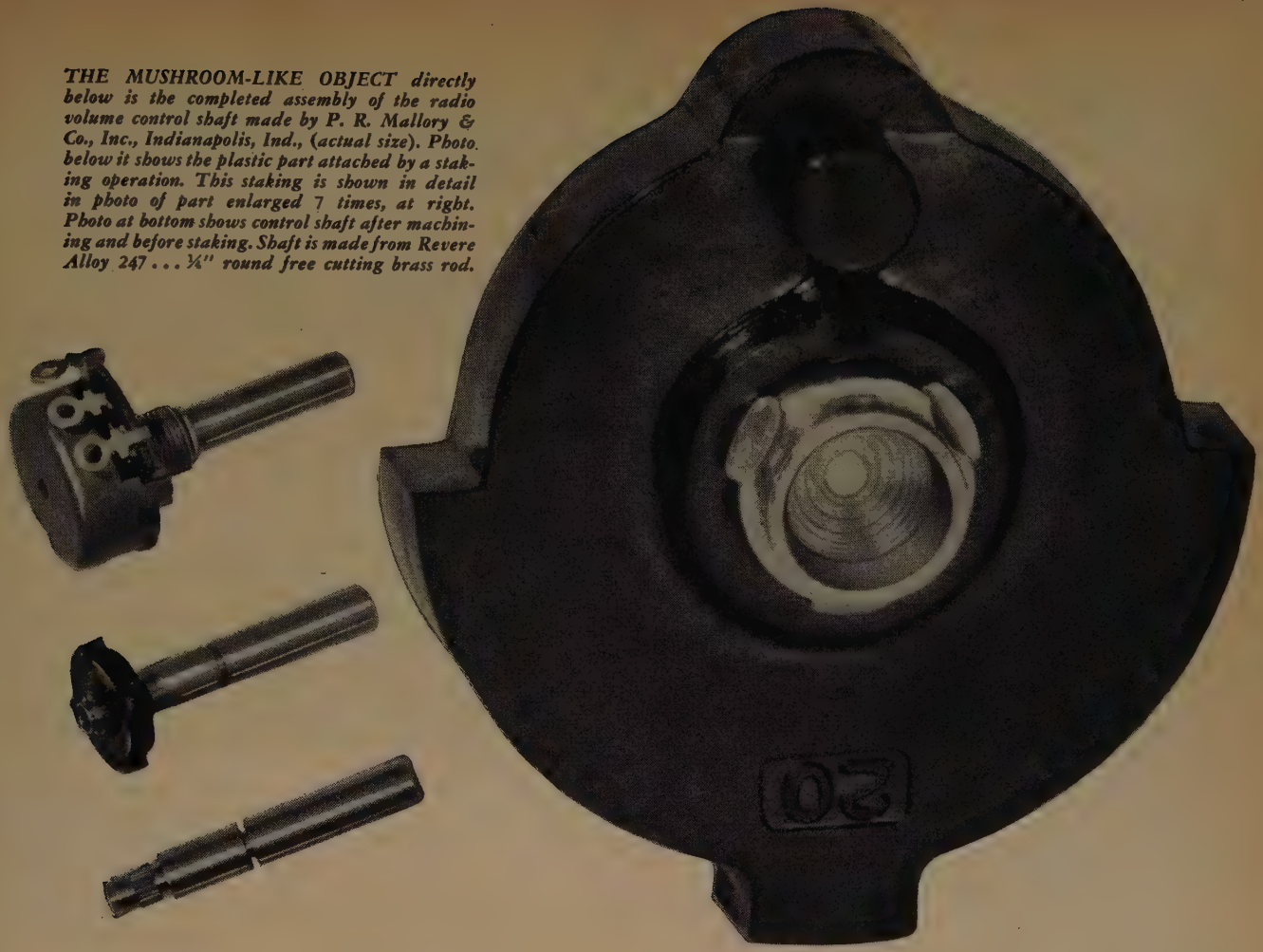
Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

- **Microwave Techniques**
- **Moving Target Indication**
- **Servomechanisms**
- **Applied Physics**
- **Gyroscopic Equipment**
- **Optical Equipment**
- **Computers**
- **Pulse Techniques**
- **Radar**
- **Fire Control**
- **Circuit Analysis**
- **Autopilot Design**
- **Applied Mathematics**
- **Electronic Subminiaturization**
- **Instrument Design**
- **Automatic Production Equipment**
- **Test Equipment**
- **Electronic Design**
- **Flight Test Instrumentation**

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

NORTH AMERICAN AVIATION, INC.
Aerophysics Laboratory
Box No. N-4, 12214 South Lakewood Blvd.
Downey, California

THE MUSHROOM-LIKE OBJECT directly below is the completed assembly of the radio volume control shaft made by P. R. Mallory & Co., Inc., Indianapolis, Ind., (actual size). Photo below it shows the plastic part attached by a staking operation. This staking is shown in detail in photo of part enlarged 7 times, at right. Photo at bottom shows control shaft after machining and before staking. Shaft is made from Revere Alloy 247 . . . ¼" round free cutting brass rod.



BY SWITCHING TO REVERE FREE CUTTING BRASS ROD P. R. MALLORY & CO., INC.,

SAVES ON 2 COUNTS!

Staking operation on radio volume control shaft performed without fracture . . . annealing operation eliminated.

The solution to the Mallory Company's problem was not as easy as it might appear. It was not simply a case of Revere Technical Advisory Service recommending ¼" round, free cutting brass rod. That rod had to possess the machinability to match Mallory's existing production machine set-up and at the same time be sufficiently workable so that annealing, prior to staking, could be eliminated; and that staking be accomplished without fracturing the metal.

After consulting with the Mallory Engineers, and discussing the tests which Mallory would subsequently conduct, Revere recommended a ¼" round, half hard riveting and turning rod mixture 247. Working tests made by Mallory showed this rod to possess all the necessary requirements.

As a result of those tests, P. R. Mallory & Company is now using this Revere free cutting brass rod to its complete satisfaction for the radio volume control shafts it manufactures. Not just any ¼" brass rod, but the *right* rod made it possible for them to save on 2 counts.

Perhaps Revere has a brass, a copper or some special alloy to help you in the development or improvement of your product . . . in cutting your production costs. So why not tell Revere *your* metal problems? Call the Revere Sales Office nearest you today.

REVERE

COPPER & BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

ENGINEERING OPPORTUNITIES IN Westinghouse

Wanted:

Design Engineers
Field Engineers
Technical Writers

Must have at least one year's experience.

For work on airborne radar, shipborne radar, radio communications equip., microwave relay, or micro-wave communications.

Good pay, excellent working conditions; advancement on individual merit; location Baltimore.

Send resume of experience and education to: Manager of Industrial Relations, Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Maryland.

PROJECT ENGINEERS

Real opportunities exist for Graduate Engineers with design and development experience in any of the following: Servomechanisms, radar, microwave techniques, microwave antenna design, communications equipment, electron optics, pulse transformers, fractional h.p. motors.

SEND COMPLETE RESUME TO EMPLOYMENT OFFICE.

SPERRY
GYROSCOPE CO.
DIVISION OF
THE SPERRY CORP.
GREAT NECK, LONG ISLAND

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

ELECTRICAL ENGINEER

Electrical engineer. Graduate of Iowa State College, June 1950, communication option. 6 months acetylene and electric welding experience. 14 months machinist apprentice training. Class A Amateur Radio Operators license. Age 24, married. Location immaterial. Box 452 W.

ENGINEER

B.E.E. Pratt Institute, June 1950, top fifth of class. Desires start in electronic control and/or servomechanism. 2 years experience in testing. Salary secondary. Box 454 W.

ENGINEER

B.E.E. Cornell, June 1950. Tau Beta Pi, Eta Kappa Nu. Some experience as laboratory assistant and in radio manufacture. Seeking position in communications or electronics development, design or research. Age 25. New York City or eastern U.S. location preferred. Starting salary secondary. Resume on request. Box 456 W.

ELECTRONICS ENGINEER

B.E.E. City College of New York, June 1950. Age 25, married. 1 year assistant in development of new oscilloscope. 1 year as electronic equipment specialist with Navy catalog office. 1 year as radio serviceman. AETM 1/c in Navy. Desires work in electronics or communications. Will relocate if necessary. Box 457 W.

ELECTRICAL ENGINEER

Electrical engineer, age 43, single. B.S.E.E. 1½ years design and development of transformers and coils for electronic equipment through manufacture. 2½ years electrical design; 1½ years Chief Electrical Engineer; 2 years engineer-draftsman; 1 year construction and inspection—power and light engineering and telephone conduit installation. Desires responsible position with electronic transformer manufacturer or research. Wish to locate southwest. Box 463 W.

Continued on page 58A)

RCA VICTOR Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 960, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

ELECTRICAL ENGINEER

Nationally known electronics firm has need in its Long Island laboratories for engineer with BS or MS to work with group on circuit & miniaturization problems, relating to electronics equipment & techniques. Must be capable of job planning & project control. Minimum 5 years experience in both audio & TV circuits and in tube component design or equipment production. Prefer engineering physicist or electrical engineer with some mechanical design experience and major interest in circuits. Send complete resume to Box IRE 1684, 221 W 41 St NYC

Potter INSTRUMENT COMPANY

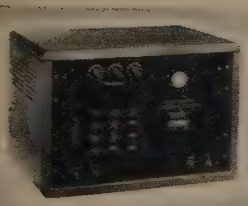
INCREASED MANUFACTURING & DEVELOPMENT FACILITIES

YOU, OUR CUSTOMERS, have been presenting us with problems which require skill not only in electronic circuitry but in unique mechanical design as well.

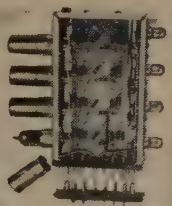
In solving many of your problems, we have found it necessary to think in terms of the most compatible combination of electronics and mechanics. Many companies are expert in one or the other of these fields, but a company which is skilled in both is rather rare. Realizing this fact, we have made a greater effort to mold our organization and facilities accordingly. Our latest step in this direction has been to construct a new plant with complete machine shop facilities and increased manufacturing space. Another goal for which we have been striving is circuit simplification. Our philosophy for the last eight years has been to design equipment with the fewest number of tubes and components without compromising on dependability. The result of this philosophy is evident in the basic 4-lamp Potter Decade and in new equipment designs yet to be announced. These include simplified and economic arithmetic units, multi-purpose shift registers, storage devices, photoelectric readers, tape handlers and a radically new high speed line-at-a-time printer. If you are concerned with problems in these fields write to Dept. 5-B for additional information.

- High Speed Electronic Counters and Scalers
- Precision Chronograph and Timing Instruments
- Frequency Measurement Counters
- Electronic Digital Computers and Memory Devices
- High Speed Printer Units and Data Handling Equipment

POTTER INSTRUMENT COMPANY
INCORPORATED
115 CUTTER MILL ROAD, GREAT NECK, NEW YORK

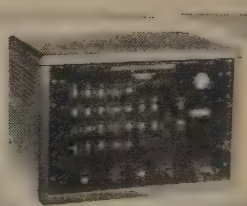


PREDETERMINED COUNTERS feature counting rates to 60,000 per minute, absolute accuracy, instantaneous automatic reset, simple dial selection of count.



DECADE COUNTER provides direct decimal read-out with the simplest most reliable decade circuit made. Finest components, superb construction.

TIME STUDY COMPUTOR—custom designed to compute operation waiting time for payroll applications, etc.; also computes most efficient combination of man and machines.



1.6 MC COUNTER CHRONOGRAPH with high resolution and accuracy (1/1,600,000 second). Indicates intervals up to 1 second. Dependable, stable, no adjustments required.

you get MORE PERFORMANCE for LESS MONEY with the NEW Browning OSCILLOSYNCHROSCOPE

For only

$485.00

this new five-inch Browning 'scope gives you the basic laboratory equipment for pulse work — in a single, compact unit with:

- **Triggered sweep** rate continuously variable from 1.0 to 25,000 microseconds per inch.
- **Sawtooth sweep** rate 10 cycles to 100 KC.
- **Sweep calibration** (triggered and sawtooth) in microseconds per screen division accurate to ±10%.
- **Vertical amplifier flat** within 3 db. from 5 cycles to 5 megacycles.
- **Sensitivity 0.075 volts** RMS per inch.
- **Horizontal amplifier d.c. to 500 KC,** sensitivity 2 volts per inch.
- **Self-calibrating** on both X and Y axis.
- **Readily portable** . . . weighs but 50 pounds.

plus these ELECTRICAL and MECHANICAL features

• 5UP1 cathode-ray tube operates at accelerating potential of 2600 volts • Sweep starting time is approximately 0.1 microsecond • Sweep may be triggered or synchronized by positive or negative sine-wave or pulse signals of 0.5 volts (external) or 0.75 inches deflection (from vertical amplifier) • Three-step attenuator — 100:1, 10:1, and 1:1, plus continuous adjustability over entire range • Peak-to-peak vertical calibration voltages of 0-2-20-200 at accuracy of ± 10% • Cathode connection, brought out to front panel, allows external blanking and marker connection • All deflection plates are available for direct connection • Steel cabinet finished in black wrinkle • Steel panel finished in black leatherette • Copper-plated steel chassis with lacquer finish • Controls grouped by function for operating convenience • Free-view screen has graduated X- and Y-axis scales • Size: 10" wide, 14½" high, 16¾" deep • Instrument draws 180 volt-amperes at 115 volts 60 cycles.

NET PRICE, F.O.B. Winchester, Mass.....$485.00

FREE BULLETIN gives further data on this new, low-cost, versatile oscillosynchroscope. Ask for data sheet ON-54E.

In Canada, address Measurement Engineering Ltd., Arnprior, Ontario

Export Sales
9 Rockefeller Plaza
Room 1422
New York 20

BROWNING
Laboratories, Inc.
Winchester, Mass.
ENGINEERED FOR ENGINEERS

Positions Wanted

(Continued from page 56A)

ELECTRONIC ENGINEER

B.S.E.E. Oklahoma Institute of Technology 1950. Communications major. 9 hours towards Masters degree. 3 years Naval Airborne radio and radar maintenance. 5½ years 1st class machinist with Sperry. Age 31, single. Desires position with future in research, development, medical electronics, communications or electronic work. Anywhere in U.S. Box 464 W.

ELECTRONIC ENGINEER

B.S.E.E. communications, Oklahoma A. and M. College, June 1950. Eta Kappa Nu. 18 hours advanced graduate work. Age 24, single. Infantry 2 years. Informal varied experience in field of electronics. Desires position in research, design or development in any phase of electronics, preferably microwaves. Location immaterial. Box 465 W.

ELECTRONIC ENGINEER

B.E.E., M.E.E. 2 years design and development work in servomechanisms, measurement equipment, electronics; 1½ years laboratory instruction in electrical engineering; 1½ years radar technician U.S. Navy. High scholastic record. Box 475 W.

COMMUNICATIONS ENGINEER

B.S.E.E. Sept. 1950, Ohio State University. Married, age 25. 6 years AM and FM broadcasting experience. Chief Engineer overseas Armed Forces radio station 8 months. 1st class radio-telephone license. Desires production or design. Box 476 W.

ELECTRICAL ENGINEER

B.S.E.E. Kansas State College, January 1950. Eta Kappa Nu, I.R.E. Age 29, married. Aircraft electrician, Army radar. Interested in sales, design or development of electronic equipment. Location and salary secondary. Box 478 W.

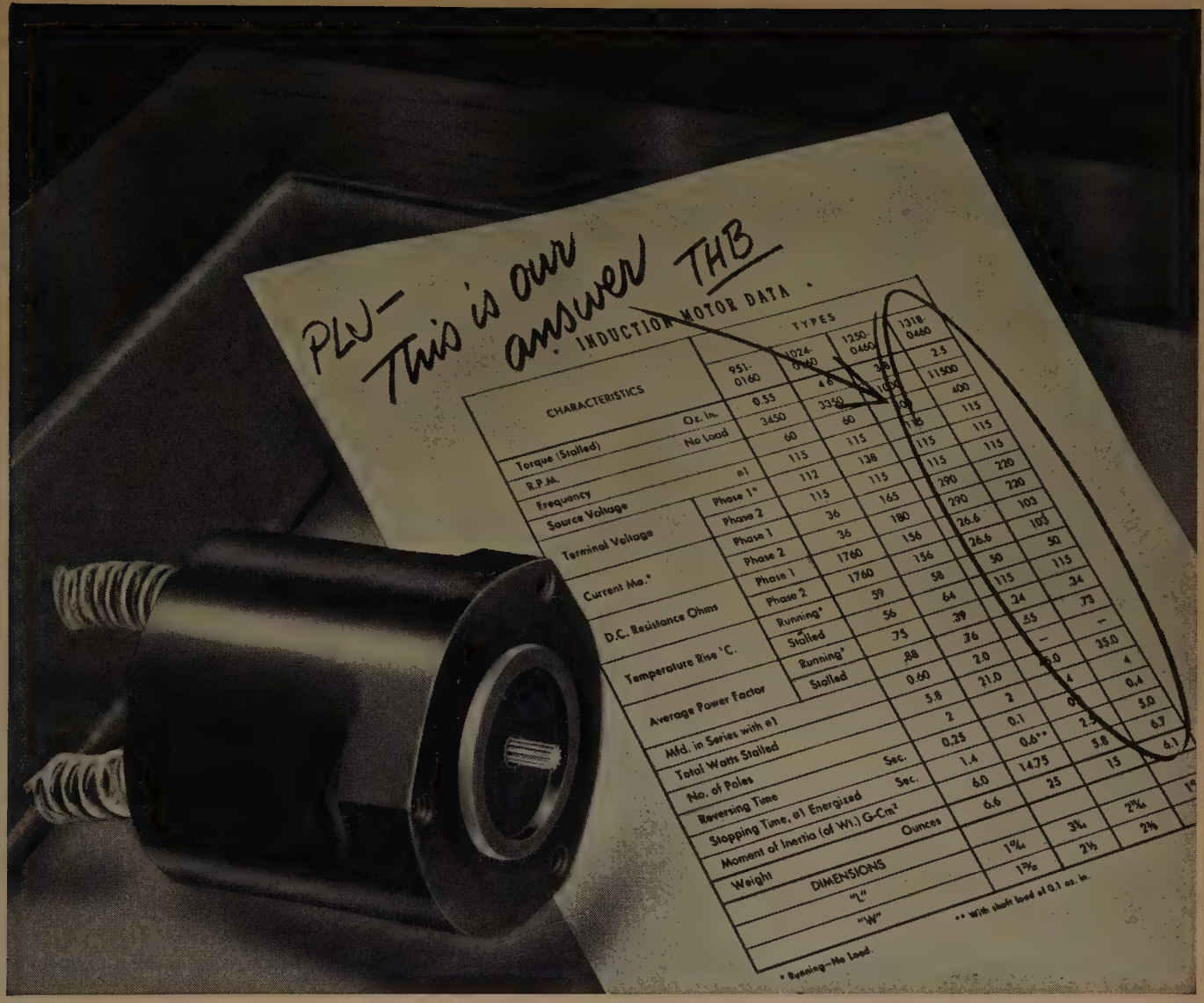
ELECTRONICS INSTRUCTOR

9 years servicing civilian and government RXs, TXs and PA systems; 6 years teaching AM, FM and TV mathematics, theory and laboratory; 2 years Navy radar training. Last positions: organized school technically and held chief instructors status 3 years. Box 479 W.

ELECTRONIC ENGINEER—PHYSICIST

6 years of physics, electrical engineering and electronics in Fordham, University of Rochester, Harvard, Mass. Institute of Technology and Brooklyn Polytechnical Institute; B.S. in physics, June 1949. 1½ years servomechanism development plus 3 years as Naval electronics officer. Age 27. Married. 2 children. Desires position in electrical engineering, technical or sales anywhere in U.S. or overseas. Box 480 W.

(Continued on page 60A)



Your answer, too, for extreme precision in remote indication and control systems

Instant responsiveness, complete smoothness of operation and a high torque/rotor inertia ratio make Kollsman Induction Motors ideally suited for use as servo or follow-up motors in control mechanisms. These miniature two-phase units have fast starting, stopping and reversing characteristics and deliver maximum torque at stall. Designed with distributed wound stators and squirrel-cage type rotors, they perform smoothly from zero to maximum r.p.m., with no "cogging" action in the low speed ranges. They may be energized by two-phase AC or by single-phase, using a phase-splitting condenser in series with one winding.

The Induction Motors constitute one series in a complete line of special purpose AC motors designed and manufactured by Kollsman, leader in the field of precision aircraft instrumentation and control. Among those available, you may find the exact answer to your control problem. If not, the skill and experience of Kollsman engineers may be relied upon to produce a unit that fulfills your particular specifications. For further information regarding these motors, address: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, New York.

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA

B&W

Coil Manufacts*

- Single layer solenoid coils
- Universal wound coils of single, multiple pie, and progressive construction
- RF, IF, and Oscillator Coils
- Traps, Discriminators, Filters, RF and Delay Line Chokes

These are but a few of the many types of coils designed and built by B&W to answer your specific needs. Whether your problems concern research, design, development, or production . . . in electronics, television, radio broadcasting, or radio communications . . . for long or short production runs—to exacting commercial or military specifications—you'll find the complete facilities of B&W able to answer your coil problems. For detailed information on coils that are recognized the world over for their consistent dependability, write today to B&W, Dept. PR-100.

*Manufacts=manufacturing facts

BARKER & WILLIAMSON, INC.

237 Fairfield Avenue — Upper Darby, Pa.

Positions Wanted

(Continued from page 58A)

ELECTRICAL ENGINEER

Recent electrical engineering graduate. Some experience. Special interest in design of VHF communications equipment, propagation studies or field surveys, and evaluation of overall system performance. Desires position continental U.S.A. Box 481W.

ELECTRONIC ENGINEER

B.E.E. June 1949, University of Delaware. Age 25, married. 3½ years Navy AETM. 1 year in nucleonic instrument maintenance, calibration, and modification. Desires research or development position in New York or Phila. area. Box 482 W.

ANTENNA ENGINEER

B.S. and M.S. in E.E., extra graduate credit. 2 years Navy electronics, 1 year part time teaching, over 2 years aircraft antenna research and development work. Age 27, married. Eta Kappa Nu, Tau Beta Pi, Sigma Xi, A.I.E.E., I.R.E. Desires research and development in VHF, UHF or microwave antennas. Box 483 W.

COMMUNICATIONS ENGINEER

B.E.E. Clarkson College, June 1950. Single, age 26. Formerly A.A.F. radar technician. Metropolitan New York area preferred. Box 484 W.

TELEVISION ENGINEER

Presently employed, 28 months equipment design and advanced development; video, pulse and special associated circuits. Seeking permanent connection with future away from metropolitan New York area. Systems engineering preferred, but will consider research or development. Present salary $5400. Credentials on request. Box 485 W.

ELECTRONIC ENGINEER

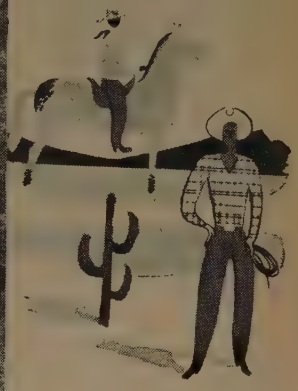
M.S.E.E. electronics, University of Illinois 1949. Age 31, married. 4 years A.A.F. radar officer, instructor. 1 year radio manufacturing. Last year and a half in geophysics, still employed. Prefer midwest or southwest. Box 486 W.

ELECTRONIC ENGINEER

B.E.E. June 1949. Communications option. Rensselaer Polytechnic Institute. 3 years elctronic technician 1/cl. U.S. Navy. 1½ years experience test and development fire and control equipment; 1 year M.B.A. at N.Y.U. major management. Position desired: test and development or project engineering with communication or electronic instruments. New York—Long Island area. Resume on request. Box 487 W.

ELECTRONIC ENGINEER

B.E.E. University of Minnesota 1948, 28, married, 2 children. Laboratory experience in pulse communication systems. Desires permanent position in west. Box 488 W.



WILCOX ...First Choice of Bonanza airlines

BONANZA AIR LINES SELECTS WILCOX TYPE 428 FACTORY PACKAGED VHF STATION *For All Ground Stations*

A WILCOX Factory Packaged Station offers you:

1. OPERATING CONVENIENCE

Conveniently grouped controls, telephone hand-set, typewriter, filing cabinet, and writing desk assure efficient operation.

2. INSTALLATION ECONOMY

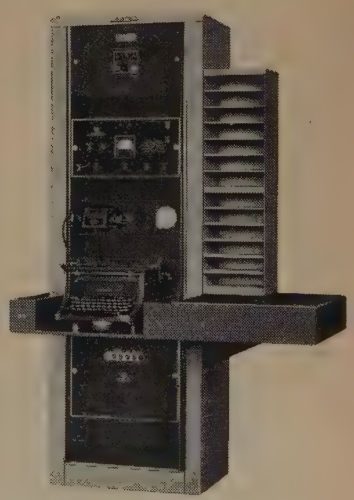
The 72-inch-high standard relay rack is completely wired at the factory. Just install the antenna, plug the station into any standard electrical outlet, and it's ready for operation.

3. MAINTENANCE EFFICIENCY

All adjustments are made from front panels. Plug and receptacle connections permit instant removal of all components. Simple circuits minimize the number and types of tubes, require no special training or test equipment.

DEPENDABLE COMMUNICATIONS FOR THE WORLD'S AIR LINES

In recent months many of the world's foremost air lines, UNITED, EASTERN, TWA, MID-CONTINENT, BRANIFF, PIONEER, ROBINSON, HAWAIIAN, SOUTHERN, and WISCONSIN CENTRAL, have placed volume orders for Wilcox equipment. No greater compliment could be paid to the performance, dependability, and economy of Wilcox equipment than to be **"FIRST CHOICE"** of this distinguished group.



The Type 428 Packaged VHF Ground Station includes 50 watt Transmitter, Receiver, Power Supply, and Antenna.

Write Today... for complete information on the Wilcox Type 428 Packaged VHF Ground Station.

WILCOX ELECTRIC COMPANY

KANSAS CITY 1, MISSOURI, U. S. A.

NEW!

THE HIGHEST GAIN COMMUNICATIONS ANTENNA EVER BUILT!

VERTICAL RADIATION PATTERN OF TYPE 3000 ANTENNA

Actually delivers 6 db . . . . . increases your power 4 times!

Now, for the first time, you can operate in areas previously far out of your reach. This vast extra service area is yours at *no additional operating cost* because the 6 db actually delivered by this new ANDREW antenna is equivalent to increasing your power 4 TIMES! Think of the economy! This tremendous extra power also fills in any dead spots.

It's another pace-setting ANDREW "first".

Uniformity of performance is assured regardless of supporting structure height through a NEW EXCLUSIVE ANDREW METHOD of electrically isolating the radiating elements from the support structure.

Lightning protection and quieter reception during electrical storms are achieved by a DC path which conducts static charges from the elements to ground.

SPECIFICATIONS
148-174 MC

TYPE NO.	3000	3001	3002
Gain	6 db	6 db	3 db
Height above top of tower	27½ ft.	27½ ft.	13½ ft.
Length of support mast extending into tower	5 ft.	5 ft.	5 ft.
Weight	625 lbs.	375 lbs.	175 lbs.
Moment at tower top*	9300 ft. lb.	6150 ft. lb.	1600 ft. lb.

*Based on 100 mph wind loading and ½" radial ice. Moments include loading added by 300 mm beacon for Type 3000 and double obstruction light for Type 3001.

Type 3000 is designed to support a 300 mm code beacon, and includes a suitable mounting plate. Type 3001 is designed to support a double obstruction light.

All models are designed for connection to ANDREW Type 737 transmission line, and are provided with climbing steps.

All orders filled chronologically. Deliveries begin September 1. Write, wire or phone (ask for Mr. Bickel) today.

Andrew CORPORATION
363 EAST 75th STREET CHICAGO 19

ANDREW

WORLD'S LARGEST ANTENNA EQUIPMENT SPECIALISTS

TRANSMISSION LINES FOR AM-FM-TV • ANTENNAS • DIRECTIONAL ANTENNA EQUIPMENT
ANTENNA TUNING UNITS • TOWER LIGHTING EQUIPMENT • CONSULTING ENGINEERING SERVICES

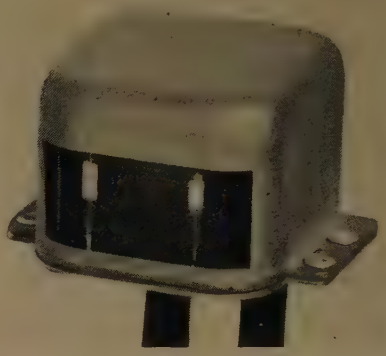
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Tape Recording Head

Shure Bothers Inc., 225 W. Huron St., Chicago, Ill., announce the development of the Model TR 5 tape recording head—they state that it is the only tape head in the field that is engineered for mass production. It combines the functions of record, playback, and erase in one versatile unit.



The TR 5 has a unique design that insures production control of gap dimension and alignment. Another special feature of the Shure tape head is the fact that it employs an effective deep-drawn, mu-metal shield for optimum hum reduction.

The TR5 is designed for ease in assembly to equipment as well as for excellent frequency response and output level. Of special interest to manufacturers of tape transport mechanisms is the low cost of the Model TR5 and its compactness.

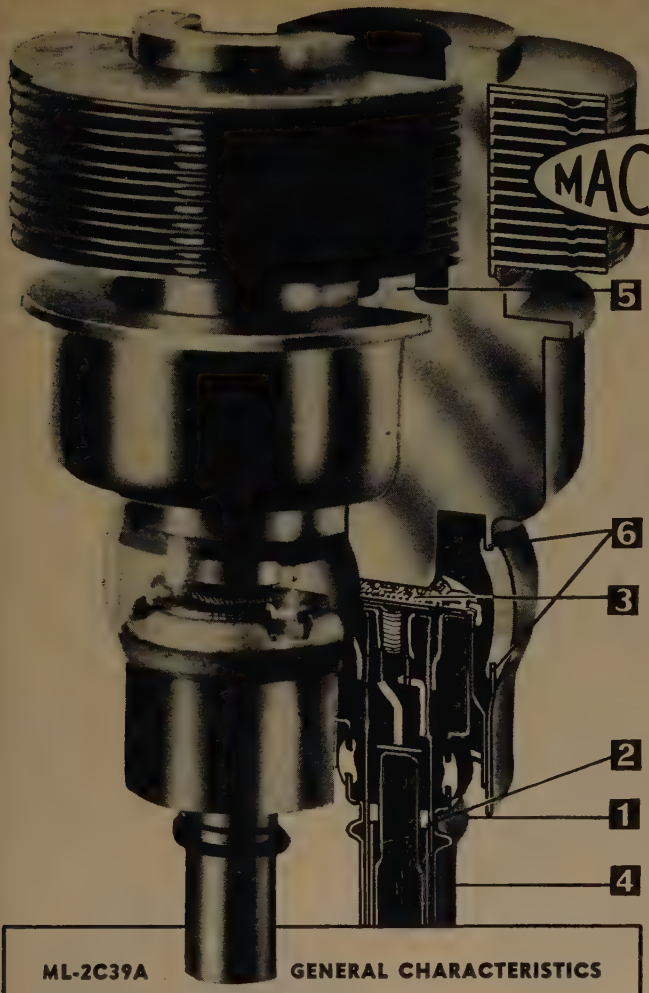
Specific technical data: record and playback coil impedance—1,650 ohms at 1,000 cps; erase coil impedance—1,000 ohms at 40 kc; output level—5 db above 1 mv at 1,000 cps (at tape speed of 3.75 inches per second); over-all dimensions—0.685 inch maximum height×1.240 width ×1.031 depth.

Pneumatic Electrode Dresser

To meet the need for redressing round electrodes of single- or multiple-point welding machines, **Keller Tool Co.,** Grand Haven, Mich., announces development of a new air-powered electrode dresser.

(Continued on page 64A)

The New ML-2C39A*...



Proving once again that MACHLETT ..makes the Difference

1. Design of cathode lead for positive adjustment and control of transconductance; limits are 20,000-23,000 μmhos or only 25% of permissible specified range.

2. High temperature ceramic in hot cathode end eliminates danger of gas evolution from glass at high temperatures. Assures better protection under overload conditions.

3. Uniquely processed mesh grid assures greater frequency stability with variation in grid dissipation.

4. Gold over silver plating to maintain optimum surface conductivity even in corrosive atmospheres.

5. Machlett's high vacuum processing for good cathode activation and freedom from gasiness.

6. Stronger glass-metal seals. Less breakage inserting and removing tubes.

** Conforms with recently issued JAN specifications.*

ML-2C39A GENERAL CHARACTERISTICS

Electrical

Cathode: Coated Unipotential	
Heater Voltage	6.3 volts
Heater Current	1.0 amperes
Amplification Factor (Average)	100
Direct Interelectrode Capacitances (Average)	
Grid Plate	1.95 μμfd.
Grid Cathode	6.50 μμfd.
Plate Cathode	0.035 μμfd.
Transconductance (i_b = 70 ma., E_b = 600 v.) (Average)	23,000 μmhos

Radio Frequency Power Amplifier
Class-C FM Telephony or Telegraphy
(key-down conditions, 1 tube)

Maximum Ratings	
D-C Plate Voltage	1000 max. volts
D-C Cathode Current	125 max. ma.
D-C Grid Voltage	−150 max. volts
Peak Positive R-F Grid Voltage	30 max. volts
Peak Negative R-F Grid Voltage	−400 max. volts
Plate Dissipation	100 max. watts
Grid Dissipation	2 max. watts

ML-381 FOR PULSED APPLICATIONS

Maximum Ratings (Tentative)

e_p, peak	3500 volts
i_p, peak	4.5 amps
i_g, peak	2.0 amps
I_p, ave	30 MA
I_g, ave	15 MA
T, pulse length	5 μ sec.
duty	1%
E_f	5.5 volts ± 5%

In all other respects the ML-381 is electrically and mechanically interchangeable with the 2C39A.

"Look to the Tube Specialist"

Long experience in the development and manufacture of the 2C39A electron tube has given Machlett Laboratories a comprehensive understanding of the operating problems encountered in a wide variety of applications of this tube type.

For assistance on your specific problem, write to Machlett Laboratories or contact your local Graybar office.

Distributed by GraybaR ELECTRIC COMPANY

MACHLETT — OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE

Specify BREEZE "Monobloc" Waterproof and Pressure Sealed CONNECTORS

The only APPROVED Monobloc System for Advanced Radar, Communications, and Electronic Equipment

Breeze "Monoblocs", with single piece plastic inserts, offer outstanding advantages in assembly, wiring, mounting and service in the field.

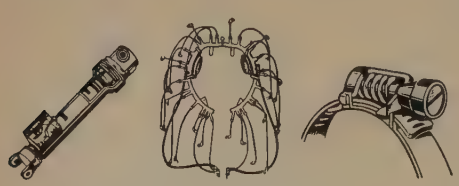
Single piece inserts make a tighter unit, eliminate the air spaces within conventional multiple-piece inserts, greatly reduce the opportunity for moisture shorts.

Removable contact pins make possible bench soldering of leads, quick, error free assembly of Breeze Waterproof Connectors and panel-type "Monobloc Miniatures."

Single-Hole Panel Mounting is all that is required for either Waterproof or Pressure Sealed types.

Pressure Sealed types are available for values up to and including 75 psi, or they can be specially engineered for greater pressures. They meet specified requirements of shock, vibration, salt spray, humidity and temperature cycling from −65° to +185° F.

Breeze "Monobloc" Waterproof and Pressure Sealed Connectors are engineered to your requirements in aluminum, brass or steel —in all sizes and capacities. They are fully tested and approved... cost no more than ordinary types.



Other Breeze Precision Products

ACTUATORS: All types, sizes. Complete control systems engineered to requirements. Above: Landing gear actuator Fairchild Packet.

RADIO SHIELDING: For any type of high or low tension system. New type "unit leads" or re-wirable leads. Flexible shielded conduit.

"AERO-SEAL" Worm-Drive Hose Clamps. Vibration proof, uniform clamping, use again and again. All clamps have stainless steel bands.

Write for Details

If you have a tough connector problem, ask BREEZE for the answer!

BREEZE

CORPORATIONS, INC.

41-G South Sixth Street, Newark 7, N.J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 62A)

The new tool, which combines the functions of both angle- and thin-type dressers, is designed to quickly restore electrodes to original shape without their removal from the welding machine.

The cutter attachment of $\frac{3}{4}$-inch thickness readily accommodates close-clearance jobs. Both Porter- and severance-type cutters can be used, the changing of cutters being made easily. Fast cutting action is provided by a free speed of 1,750 rpm.

"The new dresser," Keller engineers state, "assures uniformly dressed electrode points, eliminates hand filing methods, and reduces the usual shut-down time for servicing multiple-spindle machines."

Over-all length of the dresser is $12\frac{3}{4}$ inches, net weight, $4\frac{1}{2}$ pounds.

Radiation Monitor

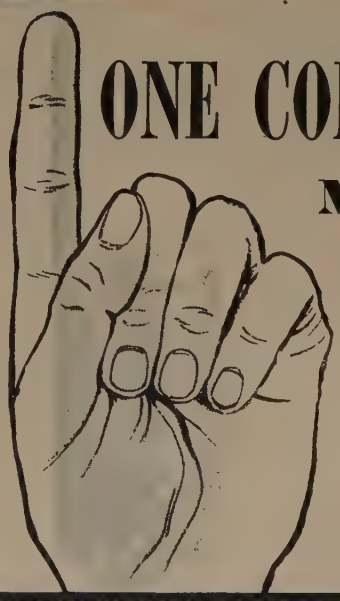
A new ac-operated radiation monitor, Model K-900, which makes it possible for the isotope laboratory worker to determine simply and quickly the contamination of laboratory accessories, benches and hands, is announced by the **Instrument Div., The Kelley-Koett Mfg. Co.,** 147 E. Sixth St., Covington, Ky., manufacturers of instruments for radiation detection and measurement.

This versatile count rate meter serves as a continuous monitor in "hot" labs. Flashing neon light and variable volume speaker respond immediately to any increases in radio-active levels in area. When provided with a contact-making meter and relay-alarm, the K-900 unit gives instantaneous, audible indication of increases in background over any predetermined level.

A large easy-to-read meter indicates either radiation rates or high voltage applied to the tube. A range and high-voltage switch on front panel selects either one of two ranges: 10,000 (×10) or 1,000 (×1) counts per minutes, full scale. The tube voltage is adjustable from 500 to 1,000 volts. When set on "calibration," an internal pulse generator synchronizes with the line frequency. Selection of 15 or 45 second time constants is permitted for the accuracy of meter reading desired.

(Continued on page 66A)

ALL RANGES WITH THIS ONE CONTROL



Model 630

Just *one* knob—extra large—easy to turn—flush with the panel, controls all ranges. This one knob saves your time—minimizes the chances of "burn-outs" because you don't have to remember to set another control. You can work fast with Model 630 with your eyes as well as your hands. Look at that scale—wide open—easy to read, accurately. Yes, this is a *smooth TV* tester. Fast, safe, no projecting knobs, or jacks, or meter case. Get your hand on that single control and you'll see why thousands of "Model 630's" are already in use in almost every kind of electrical testing

ONLY $39.50 AT YOUR DISTRIBUTOR

In Canada: Triplett Instruments of Canada, Georgetown, Ontario

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

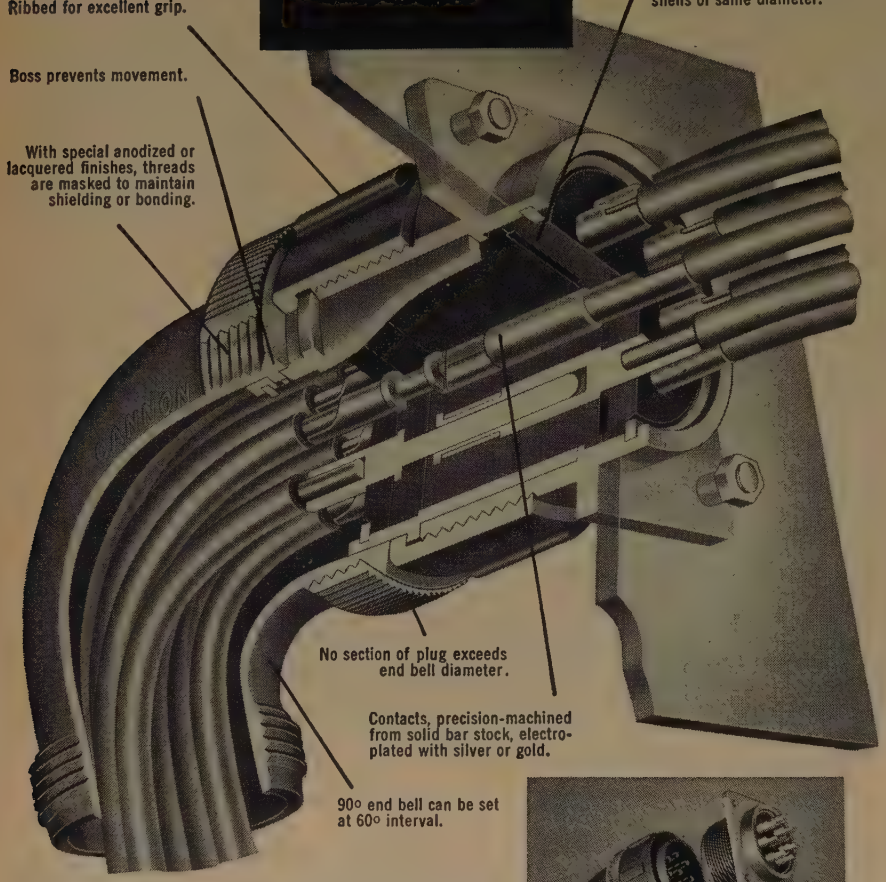
Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY · BLUFFTON, OHIO, U.S.A.

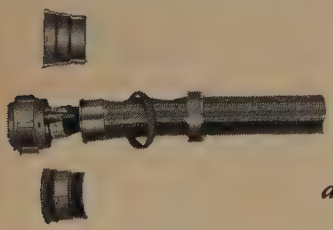
Here's why those in the know

—demand

CANNON PLUGS


Ribbed for excellent grip.
Boss prevents movement.
With special anodized or lacquered finishes, threads are masked to maintain shielding or bonding.
Interchangeable pin and socket inserts... fit all Cannon shells of same diameter.
No section of plug exceeds end bell diameter.
Contacts, precision-machined from solid bar stock, electro-plated with silver or gold.
90° end bell can be set at 60° interval.

Type AN Connectors are made in 6 styles; straight and 90° cord plugs; box, wall, and extension cord receptacles; and special quick disconnect plugs. Fifteen diameters for inserts with contact arrangements from single to 100 contacts. Contact capacities from 5 to 200 amps. Peak voltages from 70 to 9,000 volts.



Cannon split-shell design advantages

- no assembly tools needed
- end bells are interchangeable
- no slack in lines
- test without disengaging plug
- easy inspection and circuit changes

See that your circuit requirements are met. See that all control, communication and power circuits have firm positive contact, low dielectric loss ... and see that each circuit is protected by the design advantages found only in Cannon Plugs. AN Connector Series is just one of the many Cannon types—world's most complete line. Request bulletins by required type or describe the connector service you need.

CANNON ELECTRIC

Since 1915

LOS ANGELES 31, CALIFORNIA

REPRESENTATIVES IN PRINCIPAL CITIES

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 64A)

TV Receiver Calibrator

The RCA television calibrator, WR-39B, a new test instrument which is of basic usefulness in TV, providing the facilities of six important instruments for the accurate calibration of television receivers, has been announced by the **Tube Dept., Radio Corp. of America,** 415 S. Fifth St., Harrison, N. J.

Combining the accuracy of crystal control with the versatility of the variable-frequency oscillator, the company stated, the new calibrator includes in one compact, portable unit (1) a crystal-calibrated television marker generator with dual markers for all TV frequencies; (2) a bar-pattern generator for making linearity adjustments; (3) a miniature re-broadcast transmitter for checking all 12 TV channels; (4) a heterodyne frequency meter including amplifier and speaker; (5) a signal generator operating on fundamentals in all TV bands; and (6) a dual crystal standard wth three crystals supplied..

Nuclear Laboratory Monitor

A new laboratory monitor for alpha-beta-gamma detection has just been announced by **Nuclear Instrument and Chemical Corp.,** 229 W. Erie St., Chicago 10, Ill. This new Model 1615 "Radiation Sentinel" is a general purpose count rate instrument. It may be used for checking clothing, benches, glassware, hands, or fingertips for contamination, or for continuous monitoring of background air contamination or isotope decay. It may also be

(Continued on page 68A)

Shooting a bird...

IN THE AIR AGE

THIS IS "shooting a bird" at the U. S. Naval Air Missile Test Center, Point Mugu, California.

The "shoot" is the launching of a missile, while the "bird," in this particular case, is the Fairchild CTV-N-9a guided missile.

In a matter of seconds the missile is hurled high into the atmosphere with a deafening roar, propelled by its reaction type motors and auxiliary booster. Separation of the booster occurs as the missile speeds higher and higher into space, stabilized and controlled by the "intelligence" of its electronic guidance systems.

Soon the launching crews and ground observers no longer see the missile . . . but its path is being carefully plotted as it hurls toward its target . . . now under its own homing control.

This "shooting a bird" is but one phase of the Lark project. It is an operation requiring split-hair timing and perfect coordination. It is the result of teamwork between the Bureau of Aeronautics, Navy Department, the Naval Research Laboratory and Fairchild engineers and represents a combination of the best in aerodynamic design, electronic controls and precision manufacturing.

Here is another example of a Fairchild first and of "shooting a bird" . . . in the Air Age.

DEPT. OF DEFENSE PHOTOS

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD

Guided Missiles Division

Farmingdale, N.Y.

Other Divisions: **Fairchild-NEPA Division**, Oak Ridge, Tenn. • **Fairchild Aircraft Division**, Hagerstown, Md. **Fairchild Engine Division** • **Al-Fin Division** and **Stratos Corporation**, Farmingdale, N.Y.

WHEN YOU NEED A MINIATURE TRANSFORMER

CHECK THESE FEATURES OF THE HORNET

SIZE AND WEIGHT Because they are designed for high operating temperatures, Hornet Transformers and Reactors have only about one-fourth the size and weight of Class A units of comparable rating.

VOLTAGE RATINGS Designs are available for RMS test voltages up to 10,000 volts at sea level, and up to 5,000 volts at 50,000 feet altitude. Power ratings from 2VA to 5KVA.

POWER FREQUENCIES These units are designed to operate on 380/1600 cps aircraft power supplies, 60 cps power supplies, and any other required power frequency.

AMBIENT TEMPERATURES Hornet Units can be designed for ambient temperatures up to 200 deg. C. Size for any given rating depends upon ambient temperature and required life.

LIFE EXPECTANCY Extensive tests indicate that the life expectancy of Hornet units at continuous winding temperatures of 200 deg. C. is over 50,000 hours.

MOISTURE RESISTANCE Since Hornet Transformers and Reactors contain only inorganic insulation, they are far more moisture resistant than conventional Class A insulated units.

EFFICIENCY Regulation and efficiency of Hornet Transformers compare favorably with Class A units.

SPECIFICATIONS Hornet Transformers meet the requirements of Government specifications covering this type of equipment.

Bulletin B300, containing full electrical and dimensional data on Hornet units, is now available. Write for it, or tell us your specifications for special units.

NEW YORK TRANSFORMER CO., INC.
ALPHA NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 66A)

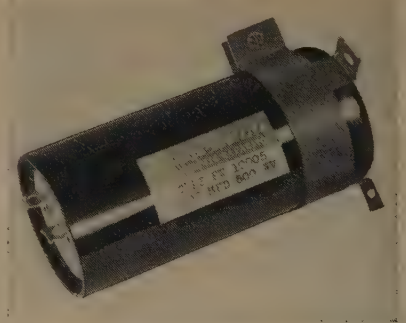
used to count samples with activities between 100 and 50,000 counts per minute where accuracy of measurement need not be better than 3 per cent standard error. A chart-type recorder may be attached for maintaining a permanent written record.

The dc outputs may be used separately, in parallel, in series, and bucking. The dc parallel operation 200 to 500 volts, 0 to 400 ma. The dc series operation 200 to 1,000 volts, 0 to 200 ma. The dc bucking operation 0 to 300 volts, 0 to 200 ma. The ac parallel operation 6.3 volts, 12 amperes. The ac series operation 12.6 volts, 6 amperes.

A choice of five different ranges, from 500 to 50,000 counts per minute full scale, is provided. Suitable time constants in each range, in conjunction with a switch permitting choice of standard error allow either 3 or 20 per cent error to be read on any range if desired. The instrument also incorporates a loudspeaker with controllable volume and a high voltage supply which is controlled from the front of the panel.

Electrolytic Capacitor

Type FW 10005, an electrolytic photoflash capacitor with an unusual number of applications, is now available from **Cornell-Dubilier Electric Corp.**, 1000 Hamilton Ave., South Plainfield, N. J.



This unit is designed for use with photoflash lamps of 900 to 1,000 volts ratings. When four units are used in series-parallel, they can deliver 100 watt-second energy. The FW-type units are in a molded bakelite case, and therefore are especially suitable for operation where good insulation due to series connection is necessary. The etched cathode construction will prevent the capacity from dropping with frequent discharges through the tube.

This capacitor has a capacity of 200 μfd and a voltage rating of 500 v. Maximum ambient temperature 100° F. Dimensions of the container are $2\frac{1}{16} \times 4\frac{7}{16}$ inches. It can be mounted with No. 20301 mounting rings.

(Continued on page 70A)

Here are some of the many reasons why there are more Simpson 260 high sensitivity volt-ohm-milliammeters in use today than all others combined. The Simpson 260 has earned world-wide acceptance because it was the first tester of its kind with all these "Firsts":

Simpson 260 SET TESTER

WORLD FAMOUS FOR ALL THESE "FIRSTS"

- First high sensitivity instrument to use a metal armature frame.
- First to use fully enclosed dust proof rotary switch with all contacts molded in place accurately and firmly.
- First to do away with harness wiring.
- First to provide separate molded recesses for resistors, batteries, etc.
- First to cover all resistors to prevent shorts and accidental damage and to protect against dust and dirt.
- First with a sturdy movement adapted to the rugged requirements of a wide range of service work or laboratory testing.
- First to provide easy means of replacing batteries.
- First to use all bakelite case and panels in volt-ohm-milliammeters.
- First volt-ohm-milliammeter at 20,000 ohms per volt with large 4½" meter supplied in compact case (size 5¼" x 7" x 3⅛").
- First and only one available with Simpson patented Roll Top Case.
- First to provide convenient compartment for test leads (Roll Top case).
- First to offer choice of colors.

RANGES

20,000 Ohms per Volt DC, 1,000 Ohms per Volt AC
VOLTS: AC & DC—2.5, 10, 50, 250, 1,000, 5,000
OUTPUT: 2.5, 10, 50, 250, 1000
MILLIAMPERES, DC: 10, 100, 500
MICROAMPERES, DC: 100
AMPERES, DC: 10
DECIBELS: (5 ranges)—12 to +55 DB
OHMS: 0-2,000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center).

Prices: *$38.95 dealers net; Roll Top $45.95 dealers net.*

The Model 260 also is available in the famous patented Roll Top safety case with built-in lead compartment. This sturdy, molded, bakelite case with Roll Top provides maximum protection for your 260 when used for servicing in the field or shop.

25,000 volt DC Probe for television servicing, complete, for use with 260, $12.85

Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY • 5200-18 W. Kinzie St., Chicago 44, Ill. • In Canada: Bach-Simpson, Ltd., London, Ont.

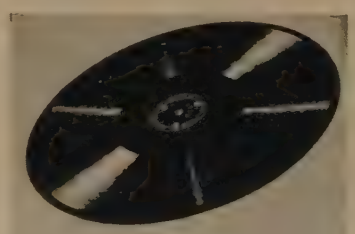
PRESTO... *most carefully made recording discs in the world*

step 3-the "Curing" process

Like fine wine, recording discs must be correctly and naturally aged. Without aging, lacquer surfaces will not engrave properly, and will result in muddy, low fidelity reproduction.

At the PRESTO disc plant, thousands of discs are allowed to "cure" under constant temperature in a dust-free atmosphere. Not one disc is allowed to leave the plant until it has been fully matured for a specified period. At PRESTO, this process is never hurried by baking or forced methods.

Careful, unhurried curing is another reason for the superiority of PRESTO discs... known throughout the world as the most carefully-made, most permanent, best performing discs available.



The famous PRESTO "Green Label" . . . world's finest recording disc.

PRESTO
RECORDING CORPORATION
Paramus, New Jersey
Mailing Address:
Box 500, Hackensack, New Jersey

In Canada:
Walter P. Downs, Ltd.
Dominion Sq. Bldg.
Montreal, Canada

Overseas:
M. Simons & Son Co., Inc.
25 Warren Street
New York, New York

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 68A)

UHF Impulse Generator

A new uhf impulse generator, producing impulses of extremely short duration, has been announced by **Empire Devices, Inc.**, 38-25 Bell Blvd., Bayside, L. I., N. Y.

The IG-102 impulse generator produces a spectrum, flat within $\pm\frac{1}{2}$ db, over the entire frequency range from 10 kc to 1,000 Mc, corresponding to a pulse width of less than 0.001 microsecond (10^{-9} seconds). The output of the instrument is 70,000 microvolts per Mc, adjustable over a 60-db range by means of a continuously variable 10-db attenuator and a resistive step attenuator.

Pulse polarity is indicated on the front panel of the instrument and automatically reverses every ten seconds.

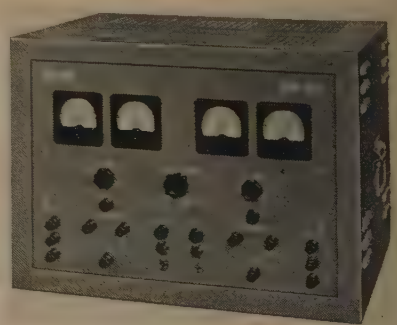
Continuously adjustable repetition rate from 2.5 to 2,500 cps is provided. In addition, single impulses may be obtained by manual keying.

The output impedance of the instrument is 50 ohms, the VSWR being better than 1.2 at all frequencies.

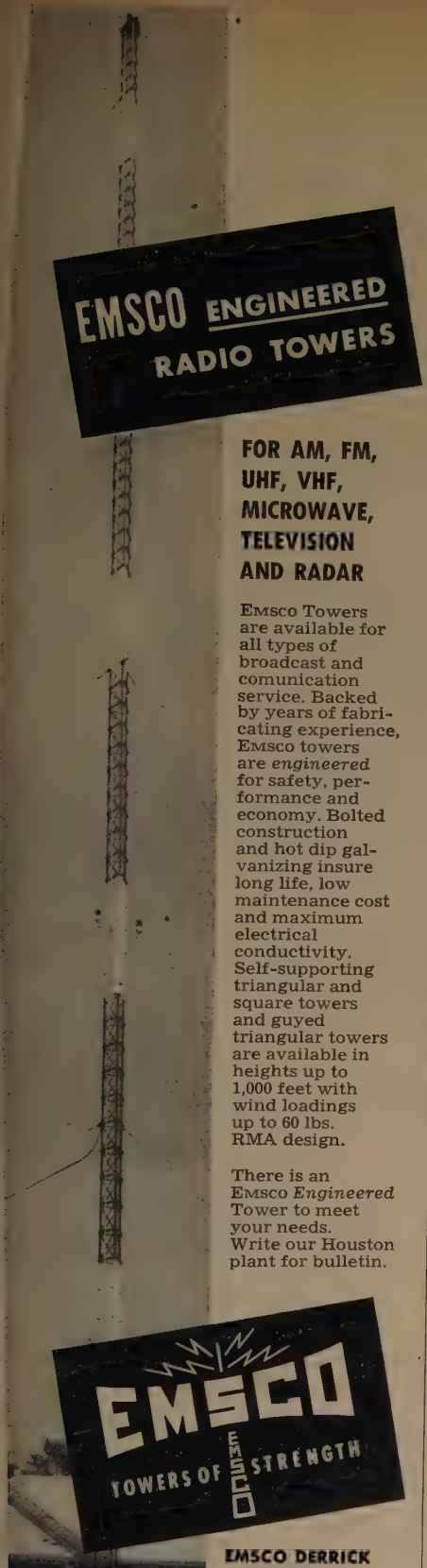
This impulse generator may be used for studying transient phenomena, ignition noise, switch and relay noise, and noise produced by rotating machinery. In addition, it may be employed for receiver alignment and bandwidth determination.

Voltage-Regulated Power Supply

The Model 510 which features two completely independent voltage-regulated power supplied with excellent regulation, low ripple content, low output impedance, fuses on input and output circuits, and output current and voltage meters has been designed and developed by **Kepco Laboratories, Inc.**, 149-14 41st Ave., Flushing, L. I., N. Y.



(Continued on page 71A)



EMSCO ENGINEERED RADIO TOWERS

FOR AM, FM, UHF, VHF, MICROWAVE, TELEVISION AND RADAR

Emsco Towers are available for all types of broadcast and comunication service. Backed by years of fabricating experience, Emsco towers are *engineered* for safety, performance and economy. Bolted construction and hot dip galvanizing insure long life, low maintenance cost and maximum electrical conductivity. Self-supporting triangular and square towers and guyed triangular towers are available in heights up to 1,000 feet with wind loadings up to 60 lbs. RMA design.

There is an Emsco *Engineered* Tower to meet your needs. Write our Houston plant for bulletin.

EMSCO TOWERS OF STRENGTH

EMSCO DERRICK & EQUIPMENT COMPANY
Houston, Texas
LOS ANGELES, CALIFORNIA
Garland, Texas

Shown here is an Emsco 20½" face, 160', type 1 RT Radio Tower with 30 lb. wind loading rating.

News—New Products

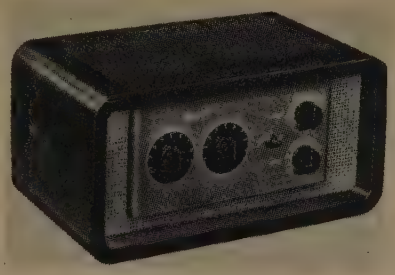
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 70A)

Each dc output voltage is continuously variable from 200 to 500 volts, 0 to 200 ma. For all output voltages, the output voltage variation is less than ½ per cent for both line fluctuation from 105 to 125 volts and load variation from minimum to maximum current. Ripple voltage is less than 5 mv. Each ac output is 6.3 volts, 6 amperes, center-tapped, unregulated. Power requirements 600 watts.

New PA Amplifier

Rauland-Borg Corp., 3523 Addison St., Chicago 18, Ill., has released the first of a new series of PA amplifiers, known as the "Green Gem" line.



(Continued on page 72A)

The nonmelting SILICONE insulating and waterproofing compound that is stable at temperatures from -70°F. to +400°F.

DOW CORNING 4 COMPOUND

↓ for ELECTRONIC EQUIPMENT

↑ for AIRCRAFT ignition and electrical control systems

MEETS ALL THE REQUIREMENTS OF AN-C-128a

More water repellent than paraffin, Dow Corning 4 Compound is highly resistant to oxygen, ozone and to deterioration caused by corona discharge.

POWER FACTOR, up to 10 megacycles . . .	0.001
VOLUME RESISTIVITY, ohm centimeters . .	10^{12}
DIELECTRIC STRENGTH, volts/mil	500

Write Today! for your copy of our new booklet on Dow Corning 4 Compound Address Dept. D.

Dow Corning FIRST IN SILICONES

DOW CORNING CORPORATION, Midland, Michigan

Just Published!

An up-to-date, thorough book which supplies the need for an authoritative treatment of the fundamental physics of semiconductors in a form accessible and useful to everyone interested in the field of transistor electronics.

ELECTRONS AND HOLES IN SEMICONDUCTORS

With Applications to Transistor Electronics

By William Shockley

Member of the Technical Staff, Bell Telephone Laboratories

Auhor of Numerous Publications on Solid Physics and Transistors

Reflecting the point of view that led to the invention of the transistor, this book develops the subject from the broadest theoretical and practical standpoints. It shows how—with the advent of the transistor—the concept of the positive hole and that of its negative counterpart, the excess electron, have assumed new technological significance and a very much greater degree of operational reality.

BASED ON EXTENSIVE LABORATORY EXPERIMENTATION

New experiments growing out of the transistor program have resulted in the direct observation of most of the important properties of electronic conduction in germanium. Experimental evidence is here used to show how electronic conduction in semiconductors occurs, both by the excess electron or negative carrier process and by the defect electron or positive hole process.

Conveniently divided into three parts: Introduction to Transistor Electronics; Descriptive Theory of Semiconductors; Quantum-Mechanical Foundations.

Scope of the material treated is suggested by this review of chapter headings: Bulk Properties of Semiconductors; The Transistor as a Circuit Element; Quantitative Studies of Hole Injection; Physical Theory of Transistors; Quantum States, Energy Bands and Brillouin Zones; Velocities and Currents for Electrons in Crystals; Electrons and Holes in Magnetic Fields; Introductory Theory of Conductivity and Hall Effect; Distribution of Quantum States in Energy; Fermi-Dirac Statistics for Semiconductors; Mathematical Theory of Conductivity and Hall Effect; Elementary Quantum Mechanics with Circuit Theory Analogues; Theory of Electron and Hole Velocities and Accelerations; Statistical Mechanics for Semiconductors; Theory of Transition Probabilities for Holes and Electrons. Clarified by numerous illustrations.

EXAMINE THIS BOOK FREE

Use the convenient order form below to obtain an examination copy of this important new work.

PLEASE CUT OUT AND MAIL

D. Van Nostrand Company, Inc. PIRE-1050
250 Fourth Avenue, New York 3, N.Y.

Please send me a copy of "Electrons and Holes in Semiconductors." Within ten days I will either return the book or send you its price, plus a few cents postage.

Name .....

Address .....

City ..... Zone..... State .....

AVOID LOSSES FROM
"NICKING"
Not being an extruded plastic, absolute uniformity of diameter can be guaranteed. Therefore:—
NO NICKING OF CONDUCTORS
NO CONSTANT RESETTING OF BLADES

specify
CORNISH
"NOFLAME-COR"
the TELEVISION hookup wire

APPROVED BY UNDERWRITERS LABORATORIES AT 90° CENTIGRADE — 600 VOLTS

Proven BEST, and specified regularly, by leading manufacturers of television, F-M, quality radio and all exacting electronic equipment. For maximum output and minimum rejects. Available in all sizes, solid and stranded. Over 200 color combinations.

PRODUCTION ENGINEERS: Specify "NOFLAME-COR" for absolute uniformity of diameter, permitting clean stripping of insulation without damage to the copper conductor...

NO NICKING OF CONDUCTORS
NO CONSTANT RESETTING OF BLADES

AVOID LOSSES FROM
"BLOBBING"
Not being an extruded plastic, eliminates the costly "blobbing" of insulations under soldering heat

• Flame Resistant • High Insulation Resistance
• Heat Resistant • Facilitates Positive Soldering
• High Dielectric • Easy Stripping
• Also unaffected by the heat of impregnation — therefore, ideal for coil and transformer leads

COMPLETE DATA AND SAMPLES ON REQUEST
"made by engineers for engineers"

CORNISH WIRE COMPANY, Inc.
605 North Michigan Avenue, Chicago 11
15 Park Row, New York 7, N.Y.
1237 Public Ledger Bldg., Philadelphia 6
MANUFACTURERS OF QUALITY WIRES AND CABLES FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

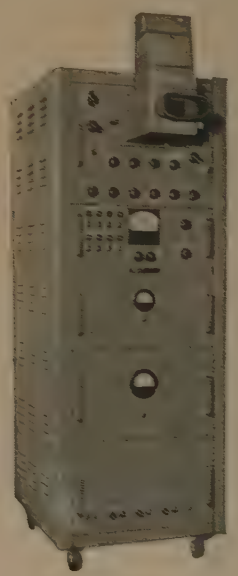
(Continued from page 71A)

The initial amplifier is the Rauland Model 1916, rated 16 watts at 5 per cent or less harmonic distortion (measured at 100, 400 and 5,000 cps); 20-watts peak output.

The Model 1916 provides: 2 microphone inputs (either convertible for use with a low-impedance mike by means of a plug-in transformer); 1 phono input; true electronic mixing and fading on all 3 inputs; tone control. Frequency response is plus or minus 1 db, 40 to 20,000 cps. Output impedances are 4-, 8-, 16-, 250-, 333-(70 volts), 500-ohms. Gain characteristics are: Mike—130 db (2 Mc); 117 db (100,000 ohms); 117 db (150 ohms). Phono—85 db ($\frac{1}{2}$ Mc). Voltage required for rated output: High impedance input—0.0015; low impedance —0.0001; phono—0.1 volt.

Impulse-Test Cathode-Ray Oscillograph

The Instrument Div., Allen B. Du Mont Laboratories, Inc., Clifton, N. J., announces the new Type 293 C-R oscillograph as an important contribution to the field of impulse-testing of high-voltage transformers, insulators, lightning arrestors, and other equipment designed to withstand surge potentials of great amplitude.

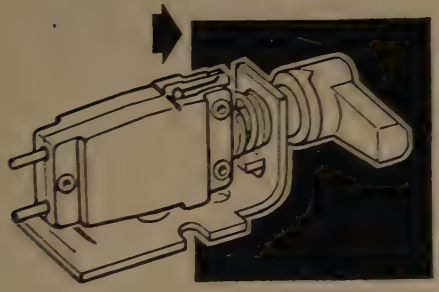


Employing a sealed-off high-vacuum cathode-ray tube and means for convenient external photographic recording, the Type 293 may be used with any standard impulse-test installation, and can be triggered by a sample of the test impulse. It also contains a pulse generator to trigger external circuits.

(Continued on page 73A)

perfect
for 3 speed playing

WEBSTER ELECTRIC MODEL "A" CARTRIDGE with TWIST MECHANISM



- Outstanding performance . . . small streamline design that fits modern tone arms.
- No chance to damage leads or play in incorrect position.
- Easy installation.

The Model "A" cartridge and twist mechanism are assembled at factory ready for installation in tone arm . . . no adjustment or modification necessary. Completely assembled it gives positive tracking at all playing speeds. High vertical and lateral compliance eliminates "skating." Positive indexing eliminates the possibility of twisting and damaging leads. The cartridge rotates through a 180 degree arc for playing either 33⅓, 45 or 78 R.P.M. records. There are no parts to get out of order. Write for data sheet and prices. Webster Electric Co., Racine, Wisconsin. Established 1909.

WEBSTER ELECTRIC
RACINE • WISCONSIN
"Where Quality is a Reasonable Price and Fair Dealing a Daily Practice"

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 72A)

Driven, logarithmic sweeps may be initiated from an external signal, internal signal, by manual push-button, or from any point in the cycle of the 60-cps line voltage. Sweep duration is adjustable in steps from 0.5 to 1,000 microseconds. Delay of the sweep, with respect to the trigger output of the instrument, is continuously variable from 0.5 to 15 microseconds, permitting detailed display of any portion of the impulse wave form.

Bandwidth of both the X and Y axes is essentially uniform from dc to 25 Mc, assuring excellent reproduction of pulses with high-frequency components. There is no distortion of pulses having a rise time of 0.01 microseconds or greater.

Interesting Abstract

To aid individual consumers, as well as industrial and professional groups, **Harvey Radio Co., Inc.,** 103 W. 43rd St., New York 18, N. Y., has constructed an "Audiotorium." All equipment on display is permanently connected to a central control panel to facilitate selection of any of the many possible audio component combinations.

(Continued on page 74A)

don't fail to see the **AMPEREX** advertisement next month announcing the **NEW AMPEREX TUBES**

You'll find the details on the inside front cover next month . . . be sure to see them.

AMPEREX ELECTRONIC CORP.
25 WASHINGTON STREET, BROOKLYN 1, N. Y.
In Canada and Newfoundland: Rogers Majestic Limited
11-19 Brentcliffe Road, Leaside, Toronto, Ontario, Canada
AMPEREX

Check these 2 NEW McGRAW-HILL BOOKS

Just Published

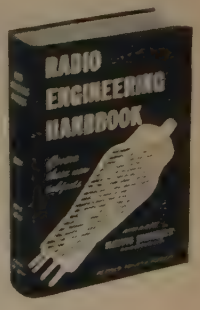
HIGH SPEED COMPUTING DEVICES

Gives a clear picture of the various mathematical methods and physical mechanisms which have been developed for use in automatic computation. HIGH-SPEED COMPUTING DEVICES explains the general character of computing machines . . . outlines the arithmetic techniques employed in their operation . . . and describes basic circuits used to perform computing machine functions. The different uses to which large-scale machines can be put are pointed out, and several computers are described. **By the staff of Engineering Research Associates, Inc., 440 pages, 90 illustrations, $6.50.**

Just Published

RADIO ENGINEERING HANDBOOK
New 4th Edition

Here are quick answers to routine and special assignments in communications, broadcasting, aircraft radio, television, and related fields. Includes data on every field and aspect of radio engineering—from inductance, power-supply systems, and electron tubes . . . to receiving systems and code reception—all arranged in concise, quick - reference form. Brings you 1197 pages of carefully selected design data—charts, tables, circuits, diagrams, and formulas. **Written by 26 specialists. Keith Henney, Editor-in-chief, Consulting Editor of Electronics. 1197 pages, 1038 illustrations, $10.00.**



SEE THESE BOOKS 10 DAYS FREE

McGraw-Hill Book Co., Inc.
330 W. 42nd St., New York 18

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery, and return unwanted book(s) postpaid. (We pay for delivery if you remit with this coupon; same return privilege.)

- ☐ ERA—High-Speed Computing Devices—$6.50
- ☐ HENNEY—Radio Engineering Handbook—$10.00

Name .....
Address .....
City ..... Zone .... State .....
Company .....
Position IRE-10-50
This offer applies to U. S. only.

NEW CONTINENTAL NOBLELOY
METAL FILM
NF RESISTOR

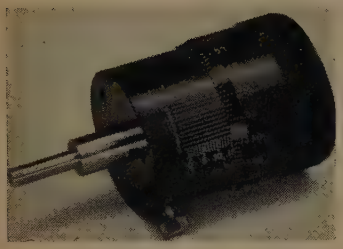
- Low Temperature Coefficient
- Range; 1 Ohm to 1 Megohm
- Axial Leads; ½ Watt
- Small Size ½" long x .150" Dia.
- Tolerance; + — 1% & 5%

Continental type NF "Nobleloy" resistors were designed to meet the needs of miniature, stable, precision resistors in critical applications.

Write for further details.

CONTINENTAL CARBON INC. CLEVELAND 11, OHIO

ONE OF OUR
PRECISION PRODUCTS



SPECIAL
MICROMETER HEAD

- Invar nut and spindle (Hard chrome plated)
- Anti-back lash screw thread
- Readable in either direction of rotation to .00005

MANUFACTURERS THREAD GRINDING, INC.
P. O. Box 66 EATONTOWN, N. J. ASBURY PARK 1-1019

TWO *NEW*
TWIN POWER SUPPLIES

MODEL 610-F

- Precise Electronic Regulation.
- 2 Independent Sources of Power.
- 0-325 V.D.C. at 0-100 Milliamperes. Continuously Adjustable.
- 0-325 V.D.C. at 0-200 Mils if the Sources are Combined.
- Both D.C. Outputs Metered for Voltage or Current.
- 6.3 and 12.6 V.A.C. Outputs Provided.
- A.C. Ripple Less than 10 Millivolts.

MODEL 1210

- Precise Electronic Regulation.
- 2 Independent Sources of Power.
- 0-500 V.D.C. at 0-150 Milliamperes. Continuously Adjustable.
- 0-500 V.D.C. at 0-300 Mils if the 2 Sources are Combined.
- Both D.C. Outputs Metered for Voltage or Current.
- 6.3 or 12.6 V.A.C. Outputs Provided.
- A.C. Ripple Less Than 10 Millivolts.

Also available with regulated bias output.

Furst *Twin* Power Supplies double the usefulness of a single unit at considerable saving in space and cost. Write for complete specifications on these and other Furst *Twin* Power Supply Models.

FURST ELECTRONICS
10 S. Jefferson St., Chicago 6, Ill.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 73A)

Stainless Steel Cathode G-M Tubes

The development of a new process which makes it possible to evaporate stainless steel on the inside of the glass walls of Geiger-Mueller tubes and on the mica windows is announced by **Tracerlab. Inc.,** 130 High St., Boston 10, Mass.

This has enabled the substitution of a stainless steel cathode coating for the previously used aquadag coating. As a consequence, the tubes have improved operating characteristics.

The life of the mica window-type tubes has been extended by a factor of 10 over the old aquadag type, and they now have a useful life of about 10^9 counts. The all-glass tubes also have a greatly increased life.

The background of these stainless steel cathode tubes is at least 30 per cent lower than that of the previous aquadag cathode tubes, and since stainless steel has a very small coefficient of electron emission by positive ion and photon bombardment, spurious counts are minimized. Furthermore, the use of stainless steel eliminates outgassing and thus decreases changes in the tube characteristics with aging.

Plant Expansion

Coral Designs, Div. Henry G. Dietz Co., formerly located in Forest Hills, New York, N. Y., is now operating in its new expanded quarters located at 12–16 Astoria Blvd., Long Island City 2, L. I., N. Y., Telephone: Ravenswood 6–3347. The facilities will be devoted to production of its standard line of electronic, electrical, and mechanical controls. It is also equipped to handle development work in the electronic field on a contract basis. Its facilities include all of the necessary equipment to produce phototypes and small-scale production of specialized electronic equipment.

(Continued on page 75A)

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

FOR SUPERIOR
PAPER-DIELECTRIC
CAPACITORS
Permanol

G-H "Custom-manufactured" capacitors treated with this highly effective impregnant insure . . . . .

Utmost protection against voltage breakdown . . .

Maximum stability under adverse climatic conditions

Low power-factor change with frequency . . .

Permanent, non-ageing characteristics . . .

GH can supply you with PERMANOL treated capacitors to your own specifications. Any reasonable capacity, tolerance or working voltage . . . any size or type of container . . . small or production quantities.

One of the best equipped capacitor manufacturing plants on the Pacific Coast

GIRARD-HOPKINS
1000 40th Avenue, Oakland 1, Calif.

ELECTRONICALLY REGULATED
LABORATORY
POWER SUPPLIES

BENCH
MODEL 25

• STABLE
• DEPENDABLE
• MODERATELY PRICED
•

- **INPUT:** 105 to 125 VAC. 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

WIDTH 14"
DEPTH 6"
HEIGHT 8"
WT: 17 LBS.

For complete information write for Bulletin G

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 74A)

Stabilized Crystal Unit

Of interest to broadcast stations is a new and improved broadcast stabilized unit, the JK57MT, recently announced by **The James Knights Co.**, Sandwich, Ill.

This new crystal features a unique and more positive method of varying the gap. Unlike conventional crystals, in which the entire electrode turns to change the frequency, the JK57M variable electrode moves only up and down in guides like a piston. This completely eliminates any danger of damaging the crystal.

The JK57MT has a frequency range from 400 to 1,750 kc. Nominal temperature 60° ±1°. Adjustable frequency in your equipment. 6.3 volt 1 ampere heater. Completely insulated, it will hold temperature to −20° C and it can be supplied with octal base (JK87MT) with or without thermometer, or factory set for operation at specific temperatures.

High-Voltage Resistors for TV

New high-voltage carbon-coated steatite-base resistors are in production at **Resistance Products Co.**, 714 Race St., Harrisburg, Pa.

Type T resistors are offered in a range of resistance values covering the requirements of TV power supply circuits, with a tolerance of ±20 per cent. Where closer tolerances are required, Type B should be specified.

The terminals are solder-type of tinned brass, fastened to the resistor by machine screws. If required, they can be furnished without terminals, to be mounted into special assemblies.

(Continued on page 76A)

Gold Plated
TUNGSTEN
and
MOLYBDENUM
GRID WIRE

Made to meet your specifications . . . for gold content, diameter and other requirements.

Write for details and list of products

SINCE 1901

SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

FOR BETTER PERFORMANCE

Output characteristics of television transformers must match the circuit exactly.

Acme Electric transformers are custom engineered to your specifications.

(illustrated) Television Power Transformer with copper shorting band.

BETTER BUY Acme ACME Electric TRANSFORMERS

ACME ELECTRIC CORPORATION • 4410 Water St., Cuba, N.Y., U.S.A.

Acme ACME Electric
TRANSFORMERS

don't crystal gaze

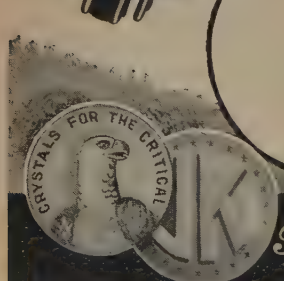
SELECT JK CRYSTALS AND BE SURE . . .

There's no guess work involved when you use JK stabilized crystals. Every JK crystal is manufactured with such care—and pride—that you can take it for granted there is none more dependable anywhere.

Next time you need crystals, specify JK crystals —and be sure!

JK STABILIZER HEAT JK02

JK stabilized heat—JK02 will accommodate two stabilized H17 crystals (HC6 type). Has standard octal base, 6.3 volt heater at less than 1 amp. Temperature stability ±2°C. Oven is normally set at +75°C. Can be supplied set at other temperatures on special order.



The James Knights Company
SANDWICH, ILLINOIS

News New—Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 75A)

32-Watt Amplifier

Rauland-Borg Corporation, 3523 Addison St., Chicago 18, Ill., has just released the second of a new series of Green Gem PA amplifiers. The Model 1932 is rated 32 watts at 5 per cent or less harmonic distortion (measured at 100, 400 and 5,000 cps); 48 watts peak output.

This Model features 3 microphone inputs (each convertible for use with a low-impedance mike by means of a plug-in transformer); 2 phono inputs with dual fader; true electronic mixing and fading on all 5 inputs; and separate bass and treble tone controls. Frequency response is ±1 db, 40 to 20,000 cps. Output impedances are 4, 8, 16, 166; (70 volts), 250-, 500-ohms. Gain characteristics are: Mike—128 db (2 Mc); 115 db (100,000 ohms); 115 db (150 ohms). Phono—82 db (1/2 Mc). Voltage required for rated output: High impedance input—0.005; low impedance—0.0004; phono—0.3 volts.

(Continued on page 77A)

All-Metal... All-Weather MOUNTS

COMPLETE and BALANCED PROTECTION

(CUP TYPE MODEL #7002)

MET-L-FLEX

Unit mounts and mounting systems with MET-L-FLEX provide vibration isolation and true shock absorption through the widest range of operating conditions. All-metal • no organic materials • stable characteristics from −90° C. to +175° C. • wide load tolerance • built-in damping for stability and reduced amplification at resonance.

For electronic or delicate equipment mounting, write Dept. 814 MET-L-FLEX Data Sheets available.

ROBINSON AVIATION INC.
TETERBORO, NEW JERSEY
Vibration Control Engineers

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 76A)

Small SWR Bridge

A new and extremely compact standing-wave ratio bridge has just been designed by the **James Millen Mfg. Co.**, 150 Exchange St., Malden, Mass. The case of the new bridge measures only $4\frac{1}{4} \times 2\frac{1}{4}$ $1\frac{5}{8}$ inches.

The bridge (catalog number 90671) is of the resistance type, and is intended for use with coaxial lines of either 52 or 75 ohm type. The compact size of the bridge makes its use convenient in most any location. It will work with any low range dc instrument such as a 0-1 milliameter, and thus makes possible an inexpensive means for making measurements of a type so necessary with all modern transmitter installations.

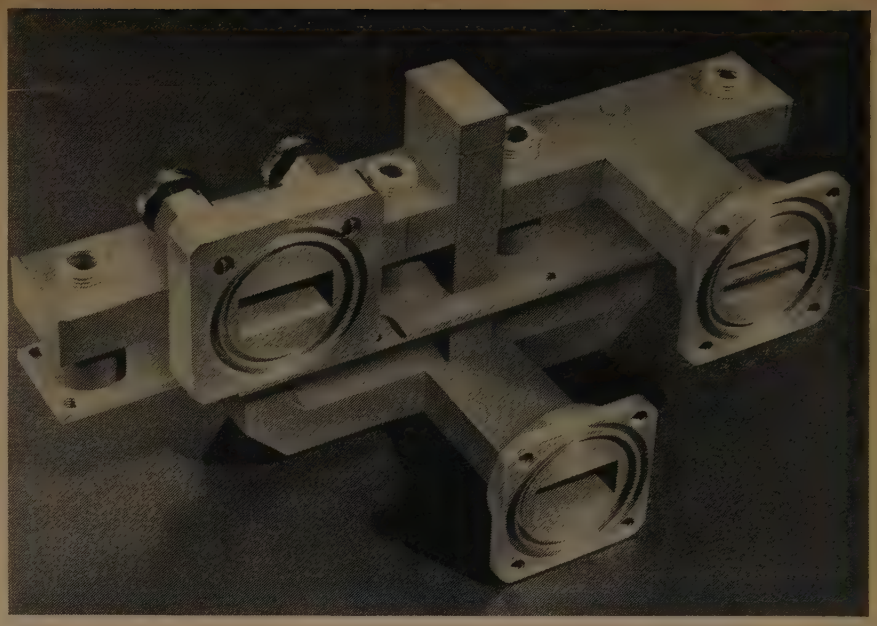
Horizontal-Deflection-Output and High-Voltage Transformer

The new horizontal-deflection-output and high-voltage transformer, RCA-223T1, and the new deflecting yoke, RCA-209D1, each utilizing a ferrite core for superior performance, are available from the **Tube Dept., Radio Corp. of America**, 415 S. Fifth St., Harrison, N. J. These compenents were designed for use with the 16GP4 and similar picture tubes having a deflection angle of about 70° and operating at an anode potential up to 14 kv.

The 223T1 is designed for use with a single, horizontal-deflection amplifier tube, such as the 6AU5-GT, and a single, high-voltage rectifier tube 1B3-GT. Because of its ferrite core, the 223T1 makes possible the design of a horizontal-deflection system which operates efficiently with a dc power supply of only 300 to 320 volts, and which provides full deflection of a 16GP4 kinescope.

The 209D1 deflecting yoke is co-ordinated in design to operate efficiently with the 223T1, and has good deflection sensitivity.

(Continued on page 78A)



Need help with microwave transmission lines?...call TERPENING

The microwave mixer shown above was designed and produced on special order, in quantity, in our plant. Though made up from a number of different sections brazed together, special jigs, fixtures, and skilled techniques made it possible to hold tolerances between the outer flange center lines to ± .001".

Whether it's a special component, such as the mixer shown, or complete microwave transmission systems, we're set up to produce them with a high degree of precision from blueprints or performance specs. Although our engineering staff, laboratories, and fully equipped shop are usually busy on government contracts, our unusual facilities may permit us to work with you on special components for military or other microwave systems. We shall be happy to talk with you about your present and/or future needs.

L. H. TERPENING COMPANY

DESIGN • RESEARCH • PRODUCTION

Microwave Transmission Lines and Associated Components

16 West 61st St. • New York 23, N. Y. • Circle 6-4760

AND SO IS Seletron

SELETRON "Safe Center" plates in miniature rectifiers eliminate the danger of arc-over, short circuits and excessive heating due to high leakage current at the center contact point. Assembly pressure, or pressure applied in mounting the rectifier cannot affect its performance. This SELETRON feature is accomplished by deactivating the area of the plate under the contact washer.

There are *millions* of SELETRON Selenium Rectifiers in service in radio and TV; millions more in other electronic circuits. That is why you can specify SELETRON and be *safe!*

Look for Howard W. Sam's Red Book Supplement listing SELETRON replacements . . . and write for your copy of our new Bulletin No. RE-5

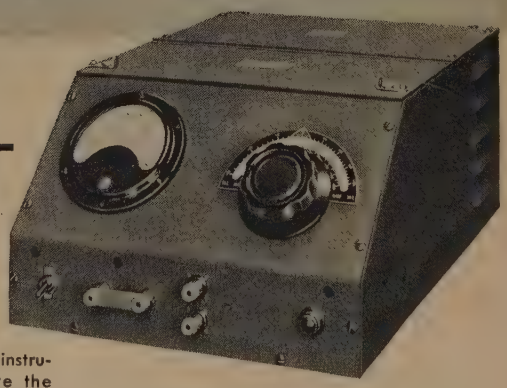
SELETRON DIVISION
RADIO RECEPTOR COMPANY, Inc.
Since 1922 in Radio and Electronics
Factory: 84 North 9th St., Brooklyn 11, N. Y. • Sales Department: 251 West 19th St., New York 11, N. Y.

CHECK small inductors

...Quickly and Accurately—

with this TYPE 110-B

QX-CHECKER



The QX-Checker is a production type test instrument specifically designed to compare the reactance and relative Q of small RF inductors with approved standards. The two factors, reactance and relative Q, are separately indicated, one on the meter and the other on a condenser dial, so that the deviation of either from established tolerances is immediately shown. Built to laboratory standards, the QX-Checker is a sturdy, foolproof instrument for use in production work by factory personnel.

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 1.5 to 25 mc. in 3 ranges using accessory plug-in-coils (two coils furnished with each instrument).

ACCURACY OF COIL CHECKS: Inductance values between 5 and 35 microhenries may be checked to an accuracy of ±0.5%. Smaller values down to 0.1 microhenries may be checked with decreasing accuracy.

INDICATING SYSTEM: Q indicating meter with well expanded 3¼" scale shows departure of Q from nominal value. Vernier condenser scale calibrated directly in terms of percent departure from known standard over range of —15% to +20%. Capacitance scale is also provided reading changes of —50 mmf. to +50 mmf. from nominal circuit capacitance of 300 mmf.

POWER SUPPLY: 110-125 volts, 50-60 cycles, also 200-250 volts, 50 cycles.

DIMENSIONS: Width 12¼", Depth 18", Height 8".

WEIGHT: 26 lbs. PRICE: $415.00 f.o.b. Boonton, N. J.

Write for Catalog

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A·

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

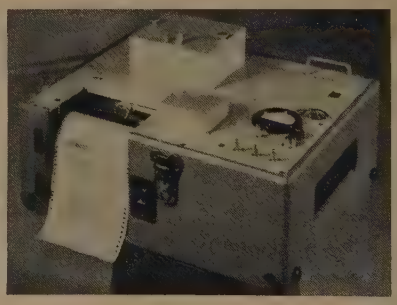
(Continued from page 77A)

New Oscilloscope

Manufactured by **Jackson Electrical Instrument Co.,** 18 S. Patterson Blvd., Dayton 1, Ohio, this new oscilloscope has a wide-band vertical amplifier response uniform from 20 cps to 4.5 Mc. It has a high sensitivity of 0.018 rms volts per inch, with response uniform to 100 kc.

A sweep oscillator provides saw-tooth wave, 20 cps to 50 kc in five steps. A sine wave sweep of 60 cps is also available. Intensity modulation, either external or internal, is 60 cps. The calibration screen is removable, and a demodulation probe is also available to use for signal tracing.

Re-Designed Frequency Response Recorder



Sound Apparatus Co., Stirling, N. J., has re-designed their frequency response recorder, Model FR. The new features are: an additional synchronous motor to operate the chart and a connection to auxiliary apparatus, such as oscillator, analyzer, etc.; a switching arrangement whereby a signal source (oscillator, analyzer) can be electrically remotely controlled from the recorder, in addition to the conventional mechanical link unit; ac and dc voltages can be recorded; the electronic circuit, an integral part of the instrument, can be easily interchanged. The new design also includes improvement of the mechanical construction. such as sturdier writing mechanism and sturdier construction of subassemblies.

(Continued on page 79A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 78A)

New Potentiometer

An ultra-low-torque potentiometer incorporating design characteristics new to the precision instrument field has been announced by **Electro-Mec Laboratory,** 225 Broadway, New York 7, N. Y. The new instrument, following laboratory and field tests, is now in commercial production.

(Continued on page 80A)

complete facilities for

DESIGN DEVELOPMENT PRODUCTION

OF U·H·F EQUIPMENT

. . . **If** UHF design or development is a major problem with you, or . . .

. . . **If** low-unit manufacturing cost is essential to satisfactorily meet competition, or . . .

. . . **If** trustworthy, confidential collaboration is a highly necessary factor . . .

THEN Lavoie Laboratories can be of invaluable, practical assistance. We have the Engineering Staff . . . the shop techniques . . . a competent understanding of government contract procedures . . . and the reputation to satisfactorily meet all those requirements.

Lavoie Laboratories, Inc.

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

The New STAVER MINI-SHIELD

TRADE MARK REG. AND PAT. PEND.

The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5½ and T6½ bulb tubes. Send for catalog sheet.

THE Staver COMPANY INCORPORATED

91 PEARL ST. • BROOKLYN 1, N. Y.
ULSTER 5-6303

SMALL PARTS

Cost less when made by

MULTI-SWAGE

The economy way to get a million small parts similar to these —

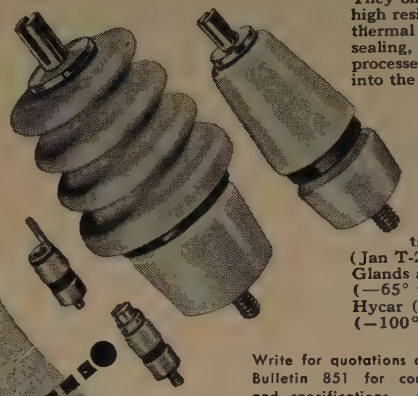
Examine the tubular metal parts shown here twice size. If you use anything similar . . . in quantities of over a million . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,

Tr. Mark 60 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

E-I HERMETIC SEALING COMPONENTS

Easy to Install — High Dielectric
GASKET TYPE BUSHINGS



For heavier equipment requiring larger terminals, E-I Gasket Type Bushings are recommended. They offer high dielectric strength, high resistance to mechanical and thermal shock, complete hermetic sealing, easy installation. Specially processed gland penetrates deeply into the L-5 Steatite insulator, seals against the mounting surface, resists oil and pitch and is unaffected by high heat. Hot-tinned brass studs provide excellent electrical conductivity.

E-I Bushings meet all government specifications for sealed transformers and condensers (Jan T-27, Jan C-25)
Glands available in Neoprene (−65° to +227°F)
Hycar (−90° to +350°F) Silastic (−100° to +500°F)

Write for quotations and descriptive Bulletin 851 for complete details and specifications — no obligation.

E-I INC
ELECTRICAL INDUSTRIES
INCORPORATED
44 SUMMER AVENUE • NEWARK 4, N. J.

Electronic PEAK to PEAK
VOLTMETER

MODEL 305

Designed for
PULSE AMPLITUDE MEASUREMENTS

The outstanding characteristic of the Model 305 Electronic Voltmeter is its ability to provide absolute indication of transient or pulse voltages of short duration. Reliable indication of pulses a few microseconds wide repeated only 20 times per second is readily obtained with this instrument. The Voltmeter is pre-calibrated, compact, easy to operate and observe. Positive and negative peaks are registered over the ranges of .001 volt to 1000 volts, peak to peak. Decade ranges and a logarithmic scale output meter are characteristic features, along with a separately available high gain, wide-band amplifier.

For further information on this and other Ballantine Voltmeters, write for catalog

BALLANTINE LABORATORIES, INC.
102 FANNY ROAD, BOONTON, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 79A)

Primarily designed as an industrial or aircraft instrument component, this potentiometer can be operated by the minute hand of a wrist watch or the pointer of an aneroid barometer, and is currently offered with a shaft torque as low as 0.003-inch ounces.

Designs of the new ultra-low-torque potentiometers are available to carry currents as high as 0.1 ampere and with outputs sufficient to operate indicating, recording, or controlling devices, without amplification. Resistance values between 50 and 200,000 ohms are provided for.

Accuracies as high as 0.05 per cent are available, and satisfactory operation under vibration at frequencies up to 200 cps have been demonstrated in actual use.

New DC Millivoltmeter and Microammeter

The new Model MV-17b dc millivoltmeter has been electronically and physically redesigned by **Millivac Instruments**, P.O. Box 3027, New Haven, Conn., so as to give performance and accuracy with a variation in calibration of less than 1 per cent for 20 per cent line voltage change.

The first stage of the carrier amplifier has an unusually high gain of over 1,000, and is directly coupled to the second stage. Internal hum pickup and tube noise are reduced by exceptionally heavy feedback of more than 1,000 to 1. All tubes are underheated, making burn-outs a rare occurance. The instrument has a sensitivity of 1 mv full scale with 6 megohms input impedance (165×10^{15} watts) and ranges up to 1,000 volts dc at 60 megohms. It may also be used as a micromicroammeter (250×10^{12} amperes full scale) with a separate shunt box, type MV-171.

(Continued on page 81A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 80A)

Vectron Spectrum Analyzer

Vectron, Inc., 235 High St., Waltham 54, Mass., announces the entirely new Vectron spectrum analyzer, covering the S and X bands.

(Continued on page 82A)

FROM THE SMALLEST TO THE LARGEST

YOU'LL DO BETTER WITH BUD

MINIBOXES

There are thousands of uses in the fields of radio and electronics for these new boxes. They are made from heavy gauge aluminum. The design of the box permits installation of more components than would be possible in the conventionally designed box of the same size. It is of two piece construction, each half forming three sides. The flange type construction assures adequate shielding. Available in etched aluminum finish and gray hammerloid finish.

Catalog Numbers Gray	Etched	Length	Width	Height	Dealer Cost Gray	Etched
CU-2100	CU-3000	2¾″	2⅛″	1⅝″	$ .57	$ .51
CU-2101	CU-3001	3¼″	2⅛″	1⅝″	.57	.51
CU-2102	CU-3002	4″	2⅛″	1⅝″	.60	.54
CU-2103	CU-3003	4″	2¼″	2¼″	.78	.72
CU-2104	CU-3004	5″	2¼″	2¼″	.81	.75
CU-2105	CU-3005	5″	4″	3″	.90	.84
CU-2106	CU-3006	5¼″	3″	2⅛″	.87	.81
CU-2107	CU-3007	6″	5″	4″	1.11	1.02
CU-2108	CU-3008	7″	5″	3″	1.26	1.14
CU-2109	CU-3009	8″	6″	3½″	1.83	1.71
CU-2110	CU-3010	10″	6″	3½″	2.25	1.89
CU-2111	CU-3011	12″	7″	4″	2.67	2.40
CU-2112	CU-3012	17″	5″	4″	3.15	2.79
CU-2113	CU-3013	10″	2″	1⅝″	.90	.84
CU-2114	CU-3014	12″	2½″	2¼″	1.23	1.05
CU-2115	CU-3015	4″	2″	2¾″	.75	.69
CU-2116	CU-3016	4¼″	2¼″	1½″	.78	.72

Prices 10% higher west of the Mississippi River

ADD-A-RACK SERIES

It has always been necessary to buy special racks without louvers on one side to obtain a maximum of panel space with a minimum of floor space. Now, you no longer need to buy a whole new cabinet when you want additional panel space. Through our new and exclusive Add-a-Rack series, BUD not only offers additional racks at a lower cost, but provides you with a sturdier, better looking assembly.

The illustration above at left shows two Add-a-Rack cabinets assembled together. The illustration above at right shows the unique and ingenious method of adding a unit to your present equipment. Instead of buying an entire new outfit, you purchase only four parts: (1) a door, (2) a top, (3) a bottom and (4) an Add-a-Rack coupling unit. The right (or left) hand side of your present relay rack is removed and replaced by the Add-a-Rack coupling unit; next, a top and bottom is fastened into place, and the side taken from the first rack is fastened onto the second rack which has been added. Place the additional door into position and you have two racks properly and efficiently coupled together.

In the same simple way, more racks can be added at any time and every one will be in a CONTINUOUS ONE-PIECE assembly.

This series is available in two ways: (1) a double unit consisting of two racks and the Add-a-Rack coupling unit, (2) Add-a-Rack unit, consisting of a door, a top, a bottom and an Add-a-Rack coupling unit. These units are furnished with all necessary assembling and panel mounting hardware.

BUD RC-7756 Casters will fit this unit. Casters are not included in price of cabinet.

Add-a-Rack Unit	To Add-a-Rack to	Overall Height	Panel Space	Dealer Cost
AR-1778	CR-1774	46 1/16″	36¾″	$28.85
AR-1775	CR-1771	47 5/16″	42″	35.00
AR-1776	CR-1772	66 9/16″	61¼″	42.00
AR-1777	CR-1773	82 5/16″	77″	52.00

Complete unit, consisting of the knocked-down parts necessary for two relay racks coupled together.

		Dealer Cost
CR-1779	two coupled relay racks same size as CR-1774	$60.20
CR-1780	two coupled relay racks same size as CR-1771	70.45
CR-1786	two coupled relay racks same size as CR-1772	87.00
CR-1799	two coupled relay racks same size as CR-1773	107.00

Prices are 10% higher west of the Mississippi River.

The above are only a few of our standard items. Send for catalog for complete information. We welcome the opportunity of quoting from your blue prints on special steel or aluminum housings.

BUD

BUD RADIO, INC.

2110 EAST 55TH STREET CLEVELAND 3, OHIO

NOW!

SPEED UP ALL SOLDERING WITH

UNGAR

FEATHER-LIGHT SOLDERING PENCILS WITH

HI-HEAT

INCREASED WATTAGE

TIPS

For use with No. 776 Handle & Cord Set

Stop wrestling with *big* irons. New HI-HEAT TIPS in your Ungar Electric Soldering Pencil produce a really versatile tool that'll perform on a par with the big, bulky 100-150 watt irons. If you can't get immediate delivery, please be patient, for production hasn't yet caught up with demand. Ask your supplier for No. 1236 Pyramid or No. 1239 Chisel. List price, $1.25 each.

Ungar ELECTRIC TOOL CO., Inc.

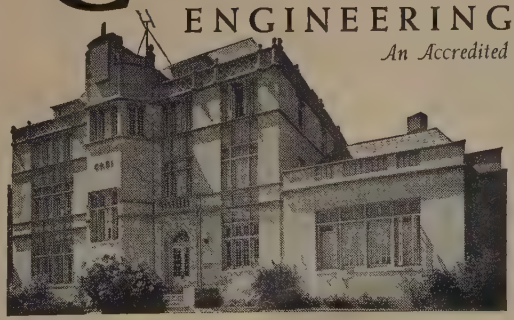
LOS ANGELES 54, CALIFORNIA

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO

ENGINEERING INSTITUTE

An Accredited Technical Institute



ADVANCED HOME STUDY AND RESIDENCE COURSES IN PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING

Request your free home study or resident school catalog by writing to:

DEPT. 2610B

16th and PARK ROAD, N.W., WASHINGTON 10, D.C.

Approved for Veteran Training

IT'S KINGS FOR CONNECTORS

Pictured here are some of the more widely used R. F. co-axial, U. H. F. and Pulse connectors. They are all Precision-made and Pressurized when required. Over 300 types available, most of them in stock.

Backed by the name KINGS—the leader in the manufacture of co-axial connectors. Write for illustrated catalogs. Department "T"

KINGS Electronics
811 LEXINGTON AVE., BROOKLYN 21, N.Y.

Manufacturers of Radar, Whip, and Aircraft antennas Microphone Plugs and Jacks.
Radar Assemblies, Cable Assemblies, Microwave and Special Electronic Equipment

THE RADIO ENGINEERING SHOW

Dates: March 19-22, 1951
Monday through Thursday
Place: Grand Central Palace, New York City
at Lexington Ave. and 46th St.

Plan to Come!

252 Exhibits—17,689 Attended in 1950

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 81A)

This analyzer has been engineered carefully to avoid obsolescence, by making provisions for rapid interchange of rf heads that will provide coverage of the microwave spectrum to 30,000 Mc. The unit features a functionally designed housing incorporating a 5-inch cathode-ray tube indicator, with a mounting that permits convenient use of a 35-mm camera for recording information from the cathode-ray tube.

New Clipper-Filter

The SA-403-A, a device for clipping and filtering speech before modulation in a radiotelephone transmitter, has been introduced by the **Standard Transformer Corp.**, 3580 Elston Ave., Chicago 18, Ill.

Measuring $1\frac{3}{4}\times1\frac{3}{4}\times4\frac{7}{8}$ inches, the SA-403-A clipper-filter requires no outboard wiring, and is designed to plug into the octal socket vacated by removing a tube in he speech amplifier circuit.

Highly effective circuits in the SA-403-A involve four triodes (two 6J6's). A control sets the peak level of amplitude modulation or frequency deviation, as the case may be.

The use of this clipper-filter for radiotelephonic transmission safeguards against overmodulation or overdeviation, and increases the effectiveness of the transmission. A higher average level of modulation is attainable. Narrow channel-width results as unnecessary high and low audio frequencies are eliminated and all modulating power is concentrated to produce the most useful sideband frequencies.

More complete details can be obtained by writing for Bulletin 360.

(Continued on page 84A)

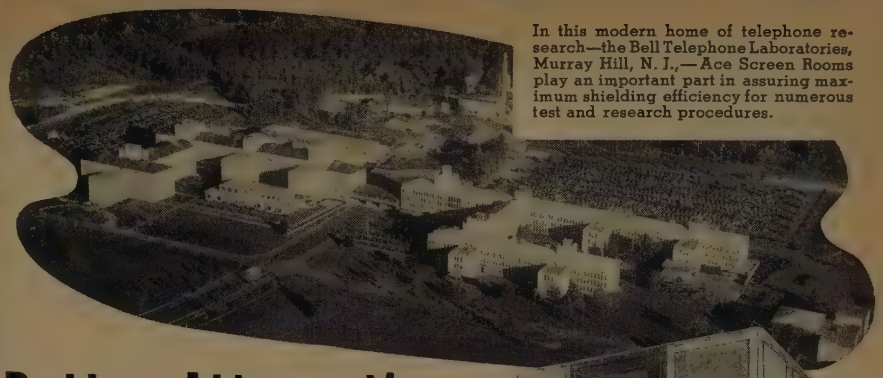
for your
Raytheon Tube Requirements
in the
Metropolitan New York Area

It's
DALIS
Phone
Algonquin
5-3000

Serving the trade for over a quarter century

H.L. DALIS INC.
Wholesale Distributors Electronic Parts
175 VARICK ST., NEW YORK 14, N.Y.
Wire or Write Dept. IND

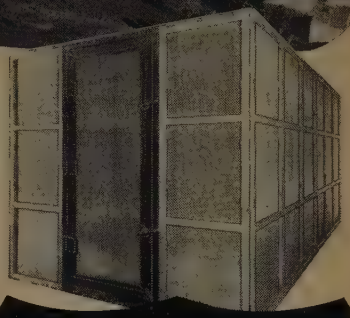
ON THE JOB AT THE FAMOUS BELL "LABS"



In this modern home of telephone research—the Bell Telephone Laboratories, Murray Hill, N. J.,—Ace Screen Rooms play an important part in assuring maximum shielding efficiency for numerous test and research procedures.

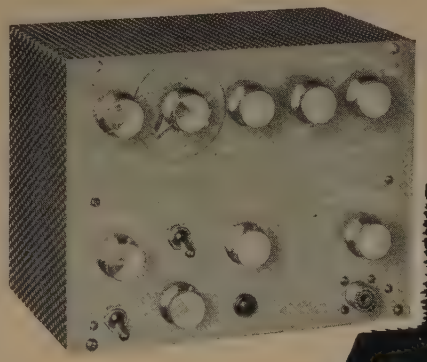
Better Attenuation
...AT NO GREATER COST!

Designed to exacting wartime laboratory standards, supplied in ready-built "knock-down" form for installation in a few hours, Ace Screen Rooms provide a minimum of 100 db. attenuation from 0.15 to 1000 mc. Total cost is no greater than that of "homemade" screen rooms of far lower efficiency. Numerous sizes are available and rooms can readily be moved or enlarged as required. Write, wire, or 'phone for details.



ACE
READY-BUILT "UNIT CELL"
SCREEN ROOMS

ACE ENGINEERING & MACHINE CO.
3642 N. Lawrence St.
Philadelphia 40, Pa. **REgent 9-1019**



THE *Berkeley*
MODEL 902
DOUBLE PULSE GENERATOR

BRIEF SPECIFICATIONS

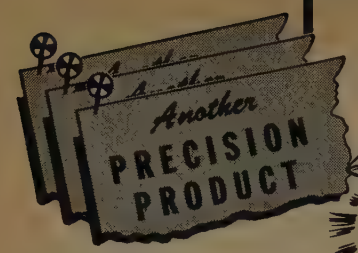
PULSE DURATION individually adjustable from 0.15 to 1.5 microseconds; RISE TIME is .05. DECAY TIME 0.10 microseconds. SPACING between pulses variable from −0.5 to +10 microseconds. REPETITION RATE adjustable in 3 ranges, 1 to 10, 10 to 100 and 100 to 1000 cycles; can be externally triggered. OUTPUT IMPEDANCE approximately 400 ohms, maximum output voltage, −200 v. CONTROL CALIBRATION ACCURACY ±5% over entire range.

The Berkeley Double Pulse Generator produces two pulses individually controllable in width, amplitude and time relation to each other. Pulse amplitude is individually adjustable without cross effect from 0 to +50 v. and 0 to −200 v. A fine control, plus a 10 to 1 step attenuator permits varying the amplitude of both pulses after mixing.

TYPICAL APPLICATIONS...Resolution tests of high speed scaling circuits, response simulation of scintillation and proportional counters, evaluation of electronic gate and switch response, TV equipment testing, characteristic checks of wide band amplifiers, etc.

COMPLETE INFORMATION *is yours for the asking; please request Bulletin IRE-902.*

Berkeley Scientific Company
SIXTH & NEVIN AVENUE • RICHMOND, CALIFORNIA



FOLLOW THE PARADE TO THE *New* Burlington *Hermetically Sealed* INSTRUMENT

JUST PLAIN RUGGED

. . . yet an instrument of highest QUALITY

. . . PRECISION

. . . ACCURACY

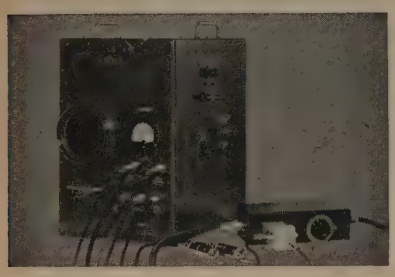
The Burlington "Hermetically Sealed" *Instrument* was designed and is manufactured to conform to JAN specifications for sealed *instruments*.

- Steel case with heavy copper-cadmium plate and black finish.
- Excellent shielding due to case material and construction.
- Double strength clear glass.
- Black satin onodized aluminum bezel.
- Glass to metal seal under controlled humidity and temperature conditions.
- D'Arsonval permanent magnet type movement for DC applications.
- Designed to enhance panel appearance.
- Available in 2½" and 3½" round case types.
- Guaranteed for one year against workmanship and materials.

Best Buy Burlington

BURLINGTON INSTRUMENT COMPANY
DEPT. I-100, BURLINGTON, IOWA

Test Equipment FOR RADAR and PULSE APPLICATIONS



MODEL 705 WOBBULATOR

Swept signal output with center frequency adjustable from 2 to 500 mc.
Continuous swept output adjustable from 0 to 100 mc./sec. with 0.1 volt output at 50 ohms.
Internally synchronized scope with detectors and amplifiers.
High and low impedance shielded traveling detectors.
Output designed for making response measurements at 3000 mc., IF frequencies, and Video.

MODEL 708 SPECTRUM ANALYZER

Frequency range—8500 mc to 9600 mc.
Receiver—Double conversion superheterodyne.
IF bandwidth—approximately 10 kc.
Sweep frequency—10 cps to 25 cps.
Minimum frequency dispersion—1 mc/inch.
Maximum frequency dispersion—10 mc/inch.
Signal input attenuator—100 db linear.
Power—115V or 230V, 50 cps to 800 cps.

Write for complete technical data

Canoga Corporation
14315 Bessemer St., Van Nuys, Calif. • Box 361

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 82A)

New Oscillosynchroscope

Browning Laboratories, Inc., 750 Main St., Winchester, Mass., announces the Model OJ-17 oscillosynchroscope, designed for use in those laboratories where the maximum oscillographic facilities is required. The high-gain vertical amplifier has a response flat from 5 cps to 16 Mc, extending beyond 30 Mc, including the use of a 0.2-microsecond signal delay line. Two completely separate sweep systems permit display of repetitive phenomena with recurrence rates as high as 10 Mc, or transient and recurrent pulses as short as 0.05 microseconds.

Built-in trigger and delay generators are provided for synchroscopic applications such as those encountered in radar circuits.

Accurate time measurements may be made by use of 0.1-, 1.0-, 10-, and 100-microsecond timing markers. Vertical signal amplitude measurements are likewise possible using a direct-reading deflection calibration system.

The high-voltage cathode-ray tube employed provides a trace sufficiently bright to be photographed even under high writing rate, single sweep conditions.

The OJ-17 consists of five separate chassis units assembled in a rack cabinet mounted on casters. A compartment is provided for permanent installation of an oscillo-record camera.

New Marine Radios

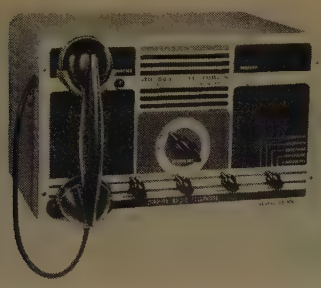
Standard Electronics Corp., Carlisle, Pa., has entered the marine radio telephone manufacturing field, with the production of four types of marine radios.

(Continued on page 85A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 84A)



The sets, which range in power from 12 to 80 watts and are designed to cover pleasure and commercial craft requirement, will be made available in a few weeks through Graybar Electric Co.

Among the four marine radios is a compact, high-powered 12-watt unit at low cost for small boats and includes a standard broadcast band that can pick up all radio broadcasts available from shore. Another model, 15 inches wide by 9 inches deep, operating at 35 watts and having five channels, is considered the most efficiently designed marine radio telephone of comparable output yet developed, the company claims.

The two larger units operate at 50 watts and 80 watts, respectively, both having six transmitting and receiving channels.

(Continued on page 86A)

HIGHEST QUALITY ELECTRONIC COMPONENTS

Large Quantities in Stock for Immediate Delivery

RELAYS — TUBES

TRANSFORMERS — CHOKES

VOLUME CONTROLS — RECTIFIERS

WIRE & CABLE — TUBE SOCKETS

RESISTORS (WIRE WOUND, CARBON, etc.)

CONDENSERS (MOLDED, CERAMIC, OIL FILLED, etc.)

SWITCHES (TOGGLE, MINIATURE, WAFER, etc.)

All standard brands, inspected and guaranteed by Wells Sales.

Manufacturers: Write for complete Electronic Catalog and prices.
Dept. P

WELLS SALES, INC.
320 N. LA SALLE ST.
CHICAGO 10, ILL.

COSSOR for QUALITY

WHEN TIMING COUNTS....
you can count on
Cossor Twin Beam Scopes

UNIQUE twin beam flat face tube permits EXACT time comparison of two waveforms without phase or frequency error. Beams are independent vertically and locked in horizontal direction, can be separated, superimposed or crossed for any comparative test . . . and . . .

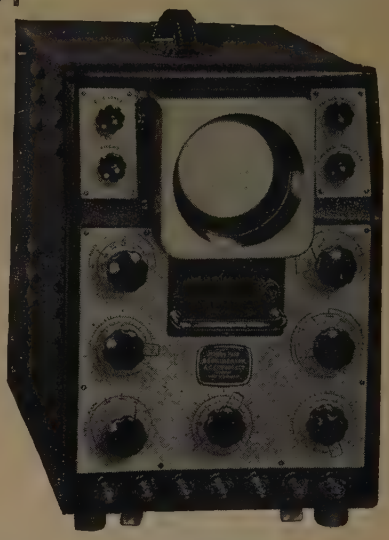
Model 1035 TWIN BEAM SCOPE (illustrated) offers these additional features:

DIRECT time measurement on calibrated controls from 150 millisec. to 1 microsec.
DIRECT voltage measurement on each beam from 500 volts to 1 millivolt.

Recurrent or triggered sweeps from 150 millisec. to 5 microsec. High gain, wideband amplifier, —3 db. at 7 Mc.

Write for details on Model 1428 Scope Camera for still or moving film records.

All instruments and spares in stock New York.



$465 fob Halifax
$650 fob New York

COSSOR (CANADA) LIMITED
301-303 Windsor Street, Halifax, N.S.
BEAM INSTRUMENTS CORPORATION
Room 907, 511 5th Avenue, New York 17, N.Y.

JOHNSON
a famous name in Radio

SMALLEST AIR VARIABLES EVER PRODUCED

Variables in Miniature

JOHNSON miniature air variable condensers save space both behind and in front of the panel. The ceramic plate measures only ⅝" wide by ¾" high. In spite of their size, these diminutive capacitors, accurately produced to close tolerances result in a completely dependable unit. Split sleeve bearings (available in plain or locking type) and soldered plate construction insure perfect alignment even in rigorous portable mobile service. A beryllium copper contact-tension spring guarantees permanent peak performance.

Three types of miniature variables are currently being produced: Single and Differential to 19.7 mmf. per section maximum capacity and Butterfly to 11.0 mmf. maximum capacity per section. Minimum capacity is held to low values. Plate spacing is .017"; peak breakdown voltage is 1250 volts.

As with all JOHNSON condensers, low loss ceramic insulation is used. Small plates and design with low inherent inductance enable the miniatures to be used efficiently at extremely high frequencies.

Write for JOHNSON Catalog 701 describing the miniature line as well as other JOHNSON variable condensers.

JOHNSON . . . *a famous name in Radio!*
E. F. JOHNSON CO., WASECA, MINNESOTA

KENYON Fits Your Production To A "T"

KENYON "T's"—high quality, uniform transformers, are your best bet for development, production and experimental work. For over 20 years, the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

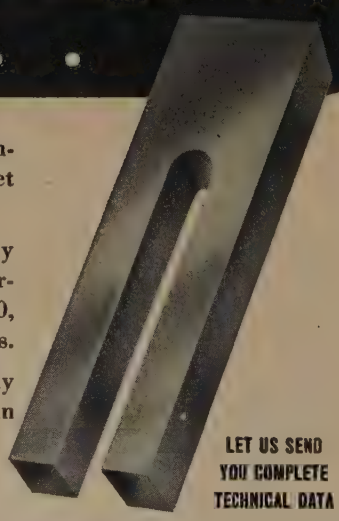
Now—reduce inventory problems, improve deliveries, maintain your quality—specify KENYON "T's," the finest transformer line for all high quality equipment applications.

New Catalog Edition! Write Today!

KENYON new modified edition tells the complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for your copy of our latest catalog edition *now!*

KENYON TRANSFORMER CO., Inc.
840 BARRY STREET · NEW YORK 59, N. Y.

Tuning Forks for precision frequency control . . . .



Philamon Laboratories manufactures a complete line of tuning fork resonators to meet your frequency control requirements.

Temperature-compensated and hermetically sealed, the resonators are available in accuracies from 1 part in 3,000 to 1 part in 100,000, for operation over wide temperature ranges.

The resonators may be obtained individually—as a part of compact sub-assemblies—or in completely engineered equipment.

LET US SEND YOU COMPLETE TECHNICAL DATA

PHILAMON LABORATORIES
5717 Third Avenue, Brooklyn 20, N. Y.

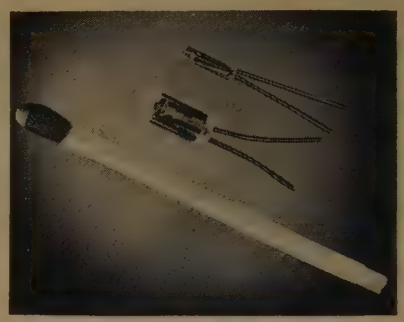
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 85A)

Subminiature Photoelectric Devices

Laboratory development of a tiny, inexpensive photocell which utilized the photosensitivity of germanium has been announced by R. M. Bowie, **Physics Laboratories, Sylvania Electric Products Inc.,** Bayside, L. I., N. Y.



These new subminiature photelectric devices are sufficiently sensitive so that useful current changes are obtained with relatively small changes in light intensity. It is anticipated that they will find wide use in such applications as decoding punched tape, electronic computing and sorting, and in the direct operation of relays such as opening and closing doors. Compactness and high sensitivity should make them well suited for many applications where cost, complexity of circuitry, and space limitation are important factors.

The new photoelectric device is essentially a germanium diode especially designed to permit use of the photoelectric properties of germanium and similar semiconductors. Experimental models have been made in which a tiny piece of germanium in contact with a fine wire or "whisker" is sealed in a solid piece of plastic about half an inch long and smaller diameter than a kitchen match. The transparent plastic, in addition to serving as a rugged sealed housing, provides an effective light path to the point at which the whisker makes contact with the germanium.

These new devices are still in the laboratory stage and have not been completed for quantity production.

Frequency Standards and Dividers

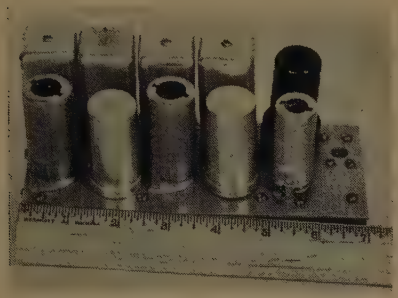
A new type frequency divider is being employed in the frequency standards of **Analysis Instrument Co.,** P.O. Box 231, East Paterson, N.J. The divider, when used in conjunction with crystal or tuning fork standard oscillators, makes possible a more compact arrangement for supplying motor drive frequencies for facsimile, watchtiming, and similar applications than were formerly available, the company claims.

(Continued on page 87A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 86A)



The picture shows a complete frequency standard for delivering 60 cps from a 90.72-kc crystal controlled oscillator; its over-all dimensions are: length, 7 inches; depth, 3 inches; and height, $3\frac{3}{4}$ inches; weighing 1 pound 3 ounces.

The frequency divider gives stable operation over wide supply voltage and ambient temperature variations. The divider can be supplied to specifications with or without frequency standards.

(Continued on page 88A)

S-S-White MOLDED RESISTORS

The "All-Weather" Resistors

S.S.WHITE RESISTORS
are of particular interest to all who need resistors with inherent *low noise level* and *good stability* in all climates.
HIGH VALUE RANGE
10 to 10,000,000 MEGOHMS
STANDARD RANGE
1000 OHMS to 9 MEGOHMS

ARE USED IN THIS ULTRA SENSITIVE ELECTRONIC PHOTOMETER

In this instrument—designed for measurement of very low light values—S.S.White Resistors serve as the grid resistance in the all-important high-gain D.C. amplifier circuit. The manufacturer, Photovolt Corp., New York, N.Y., reports that the resistors "work very satisfactorily"—which checks with the experience of the many other electronic equipment manufacturers who use S.S.White resistors.

WRITE FOR BULLETIN 4906

It gives essential data about S.S.White Resistors, including construction, characteristics, dimensions, etc. Copy with price list on request.

Photo courtesy of Photovolt Corp., New York, N.Y.

THE S-S-White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. G-R 10 East 40th St.
NEW YORK 16, N. Y.

ONLY $215* FOR THE GREEN ENGRAVER
. . . yet it's fast, versatile and rugged enough for die steel

The Green Engraver offers great speed and convenience. Quickly cuts up to four lines of letters from 3/64" to 1" on curved or flat surfaces whether made of metal, plastics or wood . . . operates by merely tracing master copy — *anyone* can do an expert job. Special attachments and engineering service available for production work. Just the thing for radio, electronic apparatus and instrument manufacturers.

For *quality* engraving on
• Panels • Name Plates • Scales • Dials • Molds • Lenses • Instruments . . . also does routing, profiling and three dimensional modeling.

Price does not include master type and special work holding fixtures.

GREEN INSTRUMENT CO.
GREEN 361 Putnam Ave. Cambridge, Mass.

WIDE BAND DIRECT COUPLED OSCILLOSCOPE

Tektronix Type 514-D

Bandwidth: *DC—10 mc*

Sensitivity: *AC—.03 v/cm*
DC—.3 v/cm

Sweep Range: *.1 μsec/cm—.01 sec/cm continuously variable*

Voltage Calibrator: *Square wave, 0—50v in 6 ranges*

The advantages of the direct coupled oscilloscope are now available in the region of 10 mc. Not only is it possible to measure the duration and amplitude of a waveform, but also the D.C. level at which it occurs.

- *Distributed type push-pull output amplifiers.*
- *All DC voltages electronically regulated.*
- *Triggered, recurrent or single sweeps.*
- *.25 μsec signal delay network.*
- *Better than 5% accuracy of timing and amplitude.*

Write or wire for complete specifications.

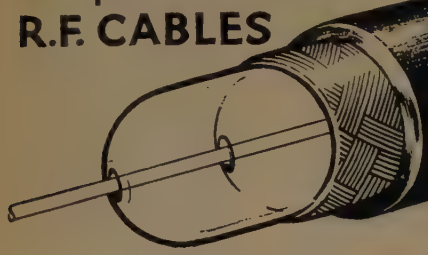
$950.00 f. o. b. Portland, Oregon

TEKTRONIX INC.
Cables, TEKTRONIX
712 S. E. HAWTHORNE BLVD. PORTLAND 14, OREGON

Only with CO-AX

air-spaced articulated R.F. CABLES

4mmf/ft



Patents Regd Trade Mark.

THE LOWEST EVER CAPACITANCE OR ATTENUATION

We are specially organised to give **SPOT DELIVERIES TO U.S.A**

Cable your rush order for shipment by air freight. Settlement by your own $ check

LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft at 100 Mc/s.	LOADING Kw Mc/s.	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	
A 34	73	0.6	1.5	0.88	HIGH POWER FLEXIBLE
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	V.L.C. ★
C44	4.1	252	2.1	1.03	

★ *Very Low Capacitance cable.*

TRANSRADIO LTD

CONTRACTORS TO H.M. GOVERNMENT

138A CROMWELL ROAD · LONDON SW7 ENGLAND

CABLES: TRANSRAD. LONDON.

SYNTHESIS

IS A HIGH CLASS WORD FOR DESIGNING SERVO MECHANISMS

...SERVOSCOPE IS A HIGH CLASS INSTRUMENT FOR SERVO SYNTHESIS!

SERVO

Write for Information

MEASURES amplitude & phase vs. frequency
CARRIERS accepted, 50 to 800 cps
MODULATES chosen carrier, 0.1 to 20 cps
ANALYZES D.C. or A.C. automatic controls
SUB-AUDIO sine generator, 0.1 to 20 cps
SQUARE WAVE generator, 0.1 to 20 cps
PHASE READING to 1° accuracy, 2 methods
LINEAR SWEEP for external use, 0.1 to 20 cps

SERVO CORP. OF AMERICA

NEW HYDE PARK, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 87A)

Impedance Measurement Equipment

The FTL-42A Impedometer is a device for the measurement of impedance in the frequency range from below 50 Mc to above 500 Mc. Below 500 Mc its accuracy is ±5 per cent. Designed by **Federal Telecommunication Laboratories, Inc.,** 500 Washington Ave., Nutley 10, N. J., the meter consists of a short length of standard $1\frac{5}{8}$-inch 52-ohm coaxial line on which are mounted two directional couplers, a voltage probe, and a capacitance plunger. On the panel, besides the capacitance button, is a switch for selecting either of the two directional couplers or the voltage probe; also a plug connected to the output of the switch. Two step adapters are furnished, $1\frac{5}{8}$ inch line to type N. Adapters for other sizes of lines and cables can be supplied.

To use the Impedometer, a signal generator is connected to one end of the line and the load to be measured is connected to the other end. A crystal detector and amplifier, or a radio receiver, is connected to the output plug on the panel. Then the switch is set consecutively to its three positions and the relative output voltage measured for the incident and reflected waves and the total voltage on the line. A simple diagram or a Smith Chart gives the impedance at the voltage probe, which can be readily transformed to the impedance at the load.

The Impedometer can also be used as a simple reflectometer for the measurement of reflection coefficient and swr.

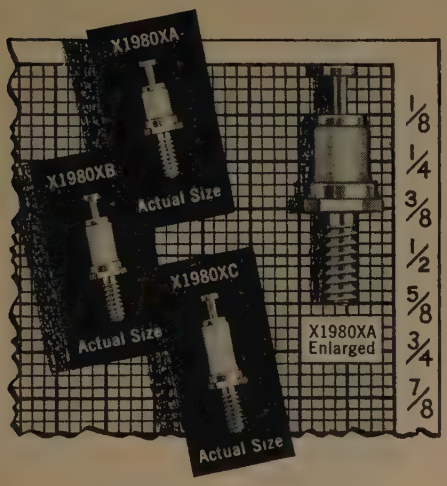
Dynamic Micro-Miker

The new Dynamic Micro-Miker should be an invaluable tool for television engineers and others concerned with wide-band amplifiers. Designed by **Kalbfell Labs., Inc.,** 1076 Morena Blvd., San Diego 10, Calif., this equipment measures the small interelectrode and wiring capacities present in video amplifiers under operating conditions, including Miller effect. It also measures the inductance of peaking coils. Thus, for the first time, it is possible to make a significant measurement of capacity for designing a peaking coil and to check the coil with one instrument.

(Continued on page 89A)

New Miniature Insulated Terminals

to help your miniaturization program



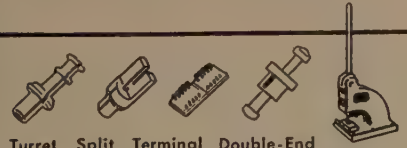
Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eighths of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .141" OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.



custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
456 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 89A)

Capacities from 0.1 $\mu\mu$f up to 0.005 $\mu\mu$f are measured in three ranges and the inductance range extends from 1 microhenry to 250 microhenries. The instrument is direct reading and unusually simple to operate.

12-Channel Television Transmitter

The **Tel-Instrument Co., Inc.,** 50 Paterson Ave., East Rutherford, N. J., Type 2111 television transmitter, is designed to provide a rapid method of production testing TV receivers on all 12 TV channels. When modulated by a composite video signal such as produced by a monoscope chain, it will provide a standard rf picture signal suitable for use as a final air check of receivers. The picture signal has an associated FM sound carrier which may be modulated at 400 cps or with music from an external source.

The Type 2111 consists of a 12-channel crystal controlled oscillator, frequency multiplier, and amplifier turret which produces the rf picture carrier on each TV channel. The rf output amplifier is suppressor grid double sideband modulated by means of a video amplifier having adequate frequency response to fully reproduce at least a 375-line signal. The video signal is obtained from an external source.

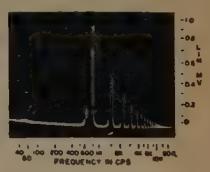
The FM sound carrier has two components 4.5 Mc above and below the picture carrier, and the TV receiver selects the upper side band while rejecting the lower. Modulation of the sound carrier is accomplished by means of the internal audio oscillator operating at 400 cps or by an external signal such as music. A standard 75-microsecond pre-emphasis network is incorporated, and 40-kc deviation may be obtained. The deviation is continuously variable by means of a panel control.

(Continued on page 90A)

***In only* 1 SECOND!**

COMPLETE AUDIO WAVEFORM ANALYSIS *with the* AP-1 PANORAMIC SONIC ANALYZER

Oscillograph of waveform to be analyzed →



Panoramic Sonic Analysis of the same wave

Provides the very utmost in *speed, simplicity* and *directness* of complex waveform analysis. In only one second the AP-1 *automatically* separates and measures the frequency and amplitude of wave components between 40 and 20,000 cps. Optimum frequency resolution is maintained throughout the entire frequency range. Measures components down to 0.1%.

- **Direct Reading**
- **Logarithmic Frequency Scale**
- **Linear and Two Decade Log Voltage Scales**
- **Input voltage range 10,000,000:1**

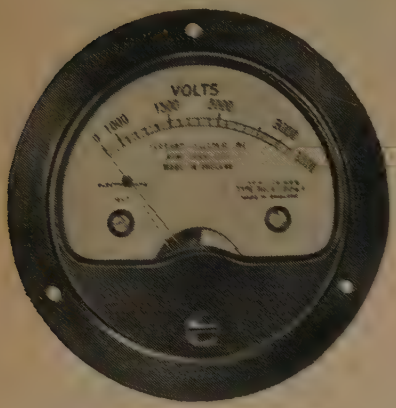
AP-1 is THE answer for practical investigations of waveforms which vary in a random manner or while operating or design constants are changed. If your problem is measurement of harmonics, high frequency vibration, noise, intermodulation, acoustics or other sonic phenomena, investigate the overall advantages offered by AP-1.

Write NOW for complete specifications, price and delivery.

See us in Room 626 at the Audio Fair, Hotel New Yorker, October 26, 27, 28, 1950.

PANORAMIC RADIO PRODUCTS Inc
10 SOUTH SECOND AVE MOUNT VERNON N.Y.

A TRUE ELECTROSTATIC VOLTMETER



This instrument permits voltage readings on AC or DC circuits of very high resistance. The only current drawn is the very small leakage current and a very low capacitance current on AC circuits. Very useful for the many high voltage—low current circuits employed in nuclear research. Available with full scale voltages ranging between 300 and 3500 volts. Special laboratory instrument available with full scale reading of 150 volts. Full scale capacitance ranges from 8 mmfds for the 3500 volt model to 100 mmfds for the 150 volt instrument. Magnetic damping. 2½" dial. Write for complete specifications.

FERRANTI

FERRANTI ELECTRIC, INC.
30 Rockefeller Plaza • New York 20, N. Y.
FERRANTI, LTD., Hollinwood, England
FERRANTI ELECTRIC, LTD., Toronto, Canada

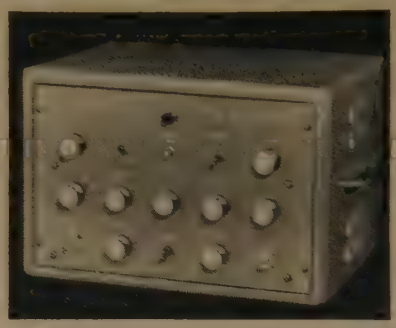
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 89A)

Double Pulse Generator

Producing two pulses individually controllable in width, amplitude, and time relation to each other, a new instrument designated as the Model 902 double pulse generator is now in production by **Berkeley Scientific Co.**, Sixth & Nevin Sts., Richmond, Calif.



Pulse amplitude is individually adjustable, without cross effect, from 0 to +50 and 0 to −200 volts. Amplitude of both pulses after mixing can be varied by means of a continuous fine control plus a 10-to-1 step attenuator. Pulse rise time is 0.05 microsecond, decay time 0.10 microsecond; duration is individually adjustable from 0.15 to 1.5 microseconds. Spacing between the two pulses is continuously variable in two ranges, −0.5 to +3 microseconds. Repetition rate is adjustable in 3 ranges: 1 to 10, 10 to 100, and 100 to 1,000 cps, and can be externally triggered. Output impedance is approximately 400 ohms; maximum output voltage is −200 v. Overall accuracy of control calibrations is ±5 per cent over the entire range.

Interesting Abstract

Available to the industry at no charge from **Magnetic Recording Div., Armour Research Foundation**, 35 W. 33 St., Chicago 16, Ill., is a comprehensive bibliography on magnetic recording. Beginning with a reprint from *The Electrical World* entitled "Some Possible Forms of Phonograph," (September 8, 1888), by Oberlin Smith, and listing 370 references through April, 1950, this booklet should be helpful to those interested in all stages of development of magnetic recording equipment.

Continued on page 92A

We will be grateful if you will mention PROCEEDINGS of the I.R.E. when writing to our advertisers.

Dependable PERFORMANCE at LOWER COST

H&P

TOWER LIGHTING EQUIPMENT

H & P lighting equipment, consistently specified by outstanding radio engineers, is furnished as standard equipment by most leading tower manufacturers.

300 MM CODE BEACON

Patented ventilator dome circulates the air, assures cooler operation, longer lamp life. Concave base with drainage port at lowest point. Glass-to-glass color screen supports virtually eliminate color screen breakage. Neoprene gaskets throughout. CAA approved

MERCURY CODE FLASHER

Lifetime-lubricated ball bearings. No contact points to wear out. Highest quality bronze gears Adjustable, 14 to 52 flashes per minute

SINGLE and DOUBLE OBSTRUCTION LIGHTS

Designed for standard A-21 traffic signal lamps Prismatic globes meet CAA specifications.

"PECA" SERIES PHOTO-ELECTRIC CONTROL

Turns lights on at 35 f.c.; off at 58 f.c., as recommended by CAA. High-wattage industrial type resistors. Low-loss circuit insulation.

ALSO COMPLETE LIGHT KITS FOR A-2, A-3, A-4 and A-5 TOWERS

PROMPT SERVICE and DELIVERY

First-day shipments out of stock. Immediate attention to specifications and unusual requirements

WRITE OR WIRE FOR CATALOG AND DETAILED INFORMATION

HUGHEY & PHILLIPS
TOWER LIGHTING DIVISION
326 N. LA CIENEGA BLVD.
LOS ANGELES 48, CALIF.
60 E. 42ND ST. NEW YORK 17, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 90A)

Three New Microphones

Stephens Manufacturing Corp., 8538 Warner Dr., Culver City, Calif., announces the introduction of a group of three microphone systems for swivel, stand, and lapel applications. Each system employs heads of extremely small size. During the testing period, production models were used as standard equipment in recording, motion picture, broadcast, and television work.

Claimed to be essentially nondirectional throughout the entire audio range, this "Tru-Sonic Microphone" is claimed to be the only microphone on the market today utilizing the advantages of the condenser-type diaphragm in a circuit which does not require vacuum-tube circuits mounted adjacent to the head.

This microphone eliminates conventional pre-amplifiers. The efficiency claimed for the unit necessitates no other amplification than the one-tube amplifier circuit incorporated in the oscillator/demodulator unit to achieve an output of −15dbm when operated in the usual sound field of 10 dynes/cm². This level is said to be equivalent to a ribbon microphone with a 40 db pre-amplifier.

Recent Catalog

. . . A new catalog, #500, presenting the complete line of transformers for broadcast, amateur, laboratory, and replacement purposes, is available to the industry from **United Transformer Co.**, 150 Varick St., New York 13, N. Y.

NOTICE

Information for our News and New Products section is warmly welcomed. News releases should be addressed to **Industry Research Division, Proceedings of I.R.E., Room 707, 303 West 42nd St., New York 18, N. Y.** Photographs, and electrotypes if not over 2" wide, are helpful. Stories should pertain to products of interest specifically to radio engineers.

. . . adds a new broadband waveguide-output klystron

Designed for high-power laboratory and antenna measurements as well as for use as a stable transmitter tube in fixed and mobile service, the new Varian X-21 Klystron covers the frequency range 9100 to 11,000 mc. It is illustrated at right above. The two resonant cavities are integral and have self-contained feedback. Output mates with standard UG/39U flange for ½- by 1- by 0.050-in. waveguide. Low microphonic construction. Weight, 4½ oz.

Typical Operation: Frequency, 10,000 mc; beam voltage, 1270 v; beam current, 98 ma; power output, 5.9 w; load VSWR, less than 1.1.

Two tunable waveguide-output reflex klystrons for the frequency range 8100 to 17,500 mc, the Varian X-12 and X-13, left and center in the illustration. Widely used for transmitter service and as local and bench oscillators as measurement power sources. Single screw tuners cover entire frequency ranges.

Typical Operation:	X-12	X-13
Frequency, mc	16,000	10,000
Beam Voltage	600	400
Beam Current, ma	50	48
Reflector Voltage	280	575
Power Output, mw	25	230
Load VSWR, max	1.1	1.1
Modulation Bandwidth, mc	50	30
Temperature Coefficient, mc per deg C, max	0.25	0.25

Now in production, two new klystrons for television service. Varian X-17 covers the range from 1990 to 2100 mc with 5 watts minimum power output. Varian X-26 Klystron group covers 5850 to 8200 mc with 0.5 watts minimum power output.

VARIAN associates

99 washington st.
san carlos, calif.

MICROWAVE TEST EQUIPMENT

PULSE EQUIPMENT

G.E.K.—2745 ..... $39.50
G.E.K.—2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS $39.50
G.E. K2450A. Will receive 13 KV .4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E. $34.50
TPS10 Modulator X Band $350.00
SO-4 Thyraton Modulator $600.00
SCR-268 Keyer units $95.00
715B Tubes $12.00
705A Tubes $2.80
705 Sockets ..... $.70

Complete line of high voltage pulse transformers, networks and dual lines.

23,000 TO 27,000 MC. BENCH TEST PLUMBING
½" x ¼" WAVEGUIDE

PRECISION SLOTTED LINE. DeMornay Budd type 337. complete with adjustable probe and crystal output. Square flanges. $400.00
PRECISION SLOTTED LINE. Adjustable probe. Humble Oil type. CPK-21HU $200.00
DIRECTIONAL COUPLER-WAVEMETER MOUNT. 12DB $60.00
PRECISION VARIABLE ATTENUATOR. mfg. Bernard Rice $90.00
TUNABLE CRYSTAL MOUNT. DB423 less tuning plunger $30.00
FLAP ATTENUATOR. DB405 10DB attenuation $25.00
LOW POWER LOAD $20.00
SCREW TUNER $25.00
SHUNT TEE $35.00
WAVEGUIDE LENGTHS. 2" to 6" long, gold-plated with circular flanges and coupling nuts ..... $2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS32 ..... $49.50
Mitered Elbow, cover to cover $4.00
TR-ATR Section, choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adaptor, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" ..... $1.00 per ft.
Circular Flanges ..... $.50
Flange Coupling Nuts ..... $.50
Slotted line, DeMornay Budd #397, new $450.00
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB ..... $49.50 ea.
K BAND 2K33 w/cav $115.00
8J31 Magnetrons $55.00

8500 Mc. to 9600 Mc. Bench Test Plumbing
1" x 1½" WAVEGUIDE

SLOTTED LINE. Complete with adjustable probe, crystal output, precision vernier adjust. Humble oil type $220.00
KLYSTRON MOUNTS. DeMornay Budd type DB380 for 2K25 etc. includes tunable termination $70.00
VARIABLE ATTENUATOR. DeMornay Budd type DB383. Maximum attenuation 35DB. $120.00
VARIABLE STUB TUNER. DB536. 180 degree phase shifting capability $70.00
FLAP ATTENUATOR. DB385. Maximum Attenuation 10DB $25.00
MAGIC TEE. DB539. ..... $42.00
WAVE GUIDE TO TYPE "N" ADAPTOR. DB377 ..... $15.00
LOW POWER TERMINATION. DB381 ..... $18.50
UNI-DIRECTIONAL COUPLER. DB390. 23DB type "N" output $18.50
PICK UP HORN. Type "N" output $4.50
WAVEMETER. 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type .. $85.00
WAVEGUIDE LENGTHS. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections ..... $2.00 per ft.
90 DEGREE ELBOWS. E or H plane, 2½" radius $12.50
MITERED ELBOWS. E or H plane $10.00
45 DEGREE OFFSET ELBOWS. E or H plane $10.00
90 DEGREE TWIST. 6" long $8.00
BULKHEAD FEED—THRU ASSEMBLY .. $15.00
PRESSURE GAUGE SECTION. 151b. gauge and press. nipple $10.00
PRESSURE GAUGE. 15 lbs. $2.50
CRYSTAL MOUNT. 1N23 type crystal holder $17.50

DUAL OSCILLATOR-BEACON MOUNT. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts., matching slugs, shields $42.50
DUAL OSCILLATOR MOUNTS. (Back to back) with crystal mount, tunable termination, attenuating slugs $18.50
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Flexible Section 18" long $12.00
Rotary Joint Choke to Choke $10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50

1¼" x ⅝" WAVEGUIDE

SLOTTED LINE. Complete with adjustable probe, crystal output, precision vernier adjust. Humble Oil type $225.00
TUNABLE TERMINATION. Precision adjust. $65.00
LOW POWER TERMINATION $25.00
MAGIC TEE $45.00
TRANSITION, 1¼" x ⅝" to 1" x ½" ... $19.50
OSCILLATOR MOUNT. for four 723AB klystron $38.50
90 DEGREE ELBOWS. E or H plane $12.50
WAVEGUIDE LENGTHS. Cut to size and supplied with 1 choke, 1 cover, per length .. $2.00 per ft.
WAVEMETER. Absorbtion type. Precision micrometer adjust. Very high Q $150.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	⅝ in.	⅝ in.	$12.50
5200	11/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons ..... $24.50 ea.
GE Magnets type M7765115, GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1⅝". New Part of SCR 584 ..... $34.50

MAGNETRONS

QK 61	2J32	2J61	720CY
QK 60	2J37	2J62	725-A
	2J21	2J38	3J31	730-A
	2J22	2J39	5J30	728
QK 915	2J26	2J40	714AY	700
QK 62	2J27	2J49	718DY	706
QK 59	2J31	2J34	720BY	

Klystrons 723A, 707B, 417A, 2K41

Write or phone for Price and Quantity
Brand New Orig. Packed J.A.N.

THERMISTORS

D-167332 (tube) .$1.50
D-170396 (bead) . 1.50
D-167613 (button) 1.50
D-164699 for MTG in "X" band Guide $2.50
D-167018 (tube) . 1.50

VARISTORS

D-170225 ..... 1.50
D-167176 ..... 1.50
D-168687 ..... 1.50
D-171812 ..... 1.50
D-171528 ..... 1.50
D-168442 ..... $3.00
D-165593 ..... $1.25
D-98836 ..... $2.00
D-161871A $2.85
D-171121 ..... 1.50
D-99836 ..... $1.50
D-162356(308A) .$1.50
D-163357 ..... $2.00
D-99946 ..... $2.95

WRITE FOR C.E.C. MICRO-WAVE CATALOG NOW AVAILABLE

COUPLINGS—UG CONNECTORS

UG/15U	$ .75	UG 117 Choke	$2.50
UG206U	.90	UG 51 Cover	1.00
UG87U	1.25	UG 52 Choke	1.35
UG27U	1.69	UG 210 Cover	1.85
UG21U	.89	UG 212 Choke	2.40
UG167U	2.25	⅞ Coax Female Ring	.50
UG29U	.90	⅞ Coax Male Fitting	.95
UG254U	1.69	X Band Circ. Choke Flange	.50
UG86U	1.40	X Band Flat Contact Flange ⅛ Thk.	.25
UG342U	3.25	Contact Ring ¼" Thk. 1⅜ dia. hole	.25
UG85U	1.45	UG 53/U, Cover	4.00
UG58U	.60	UG 54/U, Choke	4.75
UG9U	.89	UG 55/U, Cover	4.00
UG102U	.45	UG 56/U, Choke	4.75
UG103U	.45	UG 65/U, Contact	6.50
UG255U	1.65	UG 149/U, Cover	3.00
UG 40/U Speci. for Mixer Assy.	.75	UG 148/U, Choke	4.00
UG 40A	1.10	UG 150/U, Contact	3.00
UG 343 Cover	2.35	UG 39/U, Cover	.60
UG 344 Choke	3.00	UG 40/U, Choke	.80
UG 425 Contact	2.00	Write us your needs.	
UG 116 Cover & Coun Ring	1.95		

6000 Mc. to 8500 Mc. Bench Test Plumbing
1⅛" x ¾" WAVEGUIDE

KLYSTRON MOUNT. DB356 complete with shield and tunable termination $125.00
FLAP ATTENUATOR. DB361 ..... $45.00
PRECISION WAVEMETER. DB358. Micrometer adjust head $190.00
VARIABLE STUB TUNER $90.00
WAVEGUIDE TO TYPE "N" ADAPTER .. $18.50
WAVEMETER TEE. DB352 ..... $32.50
SLOTTED LINE. DB354 Precision vernier adjust. less probe $320.00
MAGIC TEE $80.00
DIRECTIONAL COUPLER. Two hole 25DB coupling, type "N" output $25.00
PRECISION CRYSTAL MOUNT. Equipped with tuning slugs and tunable termination .. $125.00
TUNABLE TERMINATION. Precision adjust $70.00
LOW POWER LOAD $35.00

4000 to 6000 mcs. Bench Test Plumbing
2" x 1" WAVEGUIDE

SLOTTED LINE. DeMornay type 332 complete with probe, etc. $600.00
FLAP ATTENUATOR $48.00
VARIABLE STUB TUNER AND LOW POWER TERMINATION $48.00
WAVEMETER TEE $48.00
ADAPTERS: Choke to choke $18.00
Cover to cover $14.00
Choke to cover $16.00
WAVEGUIDE TO TYPE "N" ADAPTER .. $45.00
DIRECTIONAL COUPLER. Two hole type, type "N" output $48.00
KLYSTRON MOUNT. Equipped with tunable termination and micrometer adjust, klystron antenna tuning $110.00
CRYSTAL MOUNT. Equipped with tunable termination and micrometer adjust crystal tuning $125.00
TUNABLE TERMINATION. Precision adjust $90.00

3000 MC BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type. Type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50
LHTR. LIGHTHOUSE ASSEMBLY, Part of RT-39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice .$47.50 ea.

S. BAND

90° Twist, circular cover to circular cover.... $25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount, Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOORNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees ..... $75.00 per set
POWER SPLITTER: 726 Klystron input dual "N" output $5.00

⅞" RIGID COAX

10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated .... $2.00 ea.
Magnetron Coupling with TR Loop $7.50
Sperry Rotating Bend, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length $7.50
Short Right Angle Bends (for above) $2.50

GENERAL TEST EQUIPMENT

Multi Frequency Generator. American Time Product type SC-16. Frequency 10 to 190. Precision Standard "Watch-Master"
UHF Signal Generator R.C.A. type 710A 370 to 560 mcs.
Wheatstone Bridge. Industrial Instruments type RN-1
FM Signal Generator. Boonton Radio type 155A Freq. range 1 to 10 mcs., 38 to 50 mcs.
Condenser Weid Power. Cap. 56 mfd. max., max. chg. 1500 Volts
Frequency Meter. Lavoie Model 105-300 to 600 mcs.
Megohm Bridge. Industrial Instruments type MB.
Visual Alignment Signal Generator. General Electric—0 to 60 mcs.

NEW TEST EQUIPMENT IN STOCK

1-185A Oscillator
1-233 Range Calibrator
1-223 Range Calibrator
BC 438 Freq. Meter
RF Preamp.
G.R. Capacity Brdg. #216
G.R. Uni Galvo Shunt #229
G.R. 1000 Aud. Osc. #213
TS226A/AP Pwr. Mtr. 0-1000 W.
Sig. Gen. #804 8-330 MC

WRITE OR PHONE FOR DATA AND PRICE

ARMY-NAVY TEST SETS

TS-45/APM—3 cm Signal Generator.
TS-226A/AP Power Meter.
TS62/AP 3 centimeter precision echo box.
TS36/AP 3 centimeter Thermistor Bridge—Power Meter.
TS89/AP Voltage divider.
TS268/U Crystal checker for IN23 type crystals etc.
CW-60ABM 10 Centimeter Wavemeter. Coaxial type micrometer adjust cavity. Resonance indicating meter, carrying case (similar to TS117/GP)
TS235/UP High Power Load, "L" band (1000 mcs.)
LU-1 Freq. Meter and Test OSC. Type CRV-60ACL
TVN-9HU Power Supply. M.I.T. Rad. Lab.
TVN-8SE Klystron Power Supply. M.I.T. Rad. Lab.
CS60ABW Watt Meter—Wavemeter. 3 centimeter.
APR5 Receiver—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC input.
Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line New $425.00
SO-3 Receiver, 30 mc. IF. 6 stages 6AC7, 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc in ch. 13 vol. 23 M.I.T. Rad. Lab. Series $99.50

All merch. guar. Mail orders promptly filled. All prices, F.O.B., N.Y.C. Send Money Order or Check. Only shipping charges sent C.O.D. Rated Concerns send P.O.

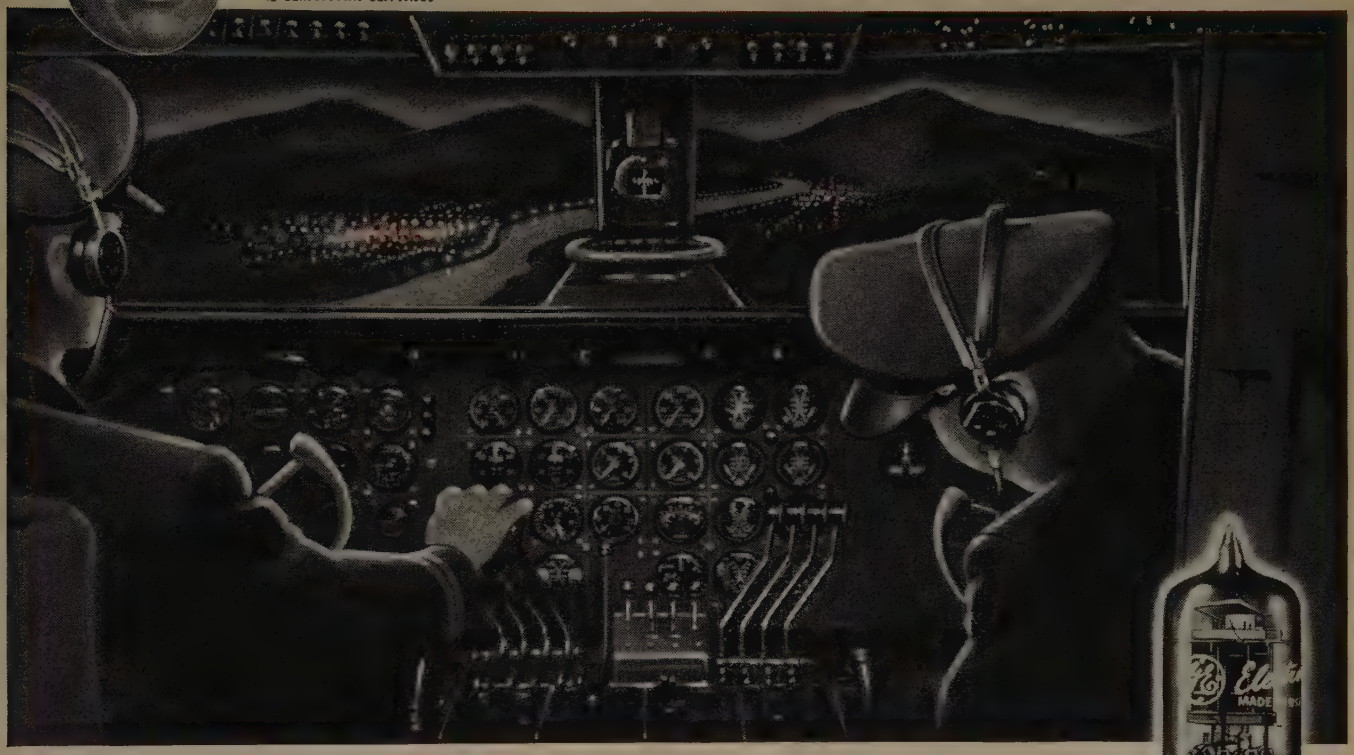
COMMUNICATIONS EQUIPMENT COMPANY

131 LIBERTY STREET, NEW YORK, N.Y. — DEPT. L-10 — P. J. PLISHNER — PHONE: DIGBY—9-4124

"with AMERICAN AIRLINES

EXTRA SAFETY IS A MUST..."

States HERSCHEL WOLF
of American Airlines



GL-5654

GL-5670

GL-5686

"...G-E High-Reliability Tubes Lift SAFETY and SAVINGS, Too!"

SAYS Herschel Wolf, in charge of aircraft radio communications for American Airlines: "You can trust G-E High-reliability Tubes to do their job *all* the time. They've helped us lift our high safety standards still higher."

You can't beat these special G-E miniatures for steady performance "under fire"—the kind of day-in, day-out job you can count on. So take a tip from American and other enthusiastic users, and specify G-E High-reliability Tubes in the equipment now on your drawing-boards! You'll lower upkeep costs, increase safety factor, widen your product's acceptance.

Altimeters, radio compasses, radio control apparatus, h-f aircraft receivers—all are employing G-E High-reliability miniatures with marked success. Every tube gets 50 hours' service at the factory under Class A conditions. Also, frequent samples are chosen for life tests, during which the tube is operated normally but intermittently by turning the heater on and off at one-minute intervals.

Communications . . . industry . . . along with aviation, find numerous applications for G-E High-reliability miniatures—the *better* tubes for *better* service where conditions are exacting! Write for further information. Learn more about what these tubes are; what they will do; how they can serve *your* needs more efficiently.
Electronics Department, General Electric Co., Schenectady 5, N. Y.

GL-5654	Sharp-cutoff r-f pentode
GL-5670	H-f twin triode
GL-5686	Power-amplifier pentode
GL-5725	Semi-remote-cutoff r-f pentode
GL-5726	Twin diode
GL-5749	Remote-cutoff r-f pentode
GL-5750	Pentagrid converter
GL-5751	High-mu twin triode
GL-5814	Medium-mu twin triode

GENERAL ELECTRIC

180-J6

WITH TEINER-SPUN CONES

For faster production of jet parts, TV cones, or experimental designs, call Teiner. Capacity is immediately available for sheet metal working and spinning of all metals.

Automatic machines for TV cones, power tools for spinnings up to 16 ft. and facilities for handling stainless steel and new Timken alloy can be applied to your fabrication needs.

For shrouds, reflectors, hemispheres, guards, baffles, conical, spherical or parabolic shapes, flanged or dished heads or special designs, send samples or drawings for prompt estimates.

Save time and money — Consult Teiner

ROLAND TEINER CO. INC. · EVERETT · MASSACHUSETTS

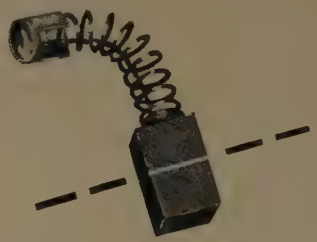
ROLAND TEINER COMPANY, INCORPORATED
134 TREMONT ST., EVERETT 49, MASS. Tel. EV 7-7800

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Marked Brushes Aid in Brush Replacement

Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Ill., has developed a way to measure brush life so that replacements may be made before service fails or damage occurs.



Described as Line-O-Life, these brushes are interchangeable with older types of similar size, and are in all respects similar, except for the addition of a visual indicator line impressed across the top of the brush at a point indicating full service life. When worn down to this Line-O-Life, brushes should be replaced.

Excessive brush wear results in poor contact, sparking, worn and grooved commutators. These brushes avoid serious trouble by showing you when replacements should be made.

For descriptive literature on converters and dynamotor power supplies equipped with new Line-O-Life brushes, write to Carter Motor Co.

New Nuclear Scaler

Described as the first of a series of "building block" units, the **Atomic Instrument Co.,** 84 Massachusetts Ave., Boston 39, Mass., announced that their new 1010 scaler is now in production and is available for delivery.

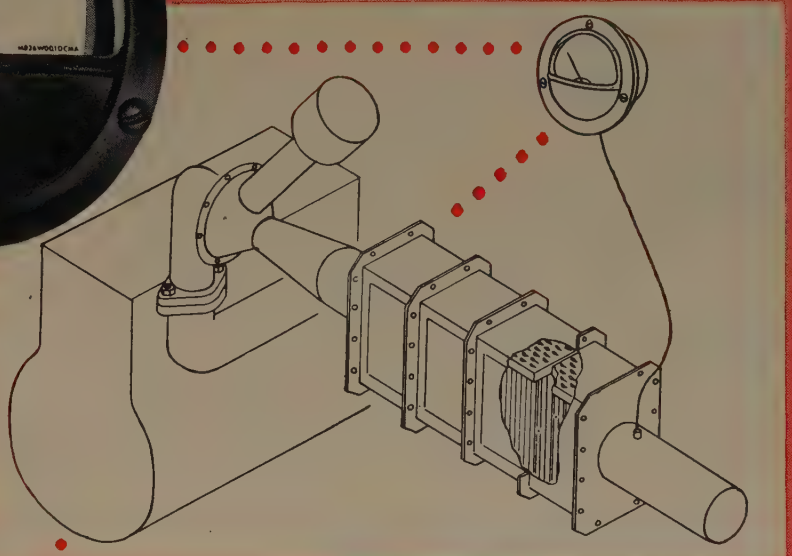
The standard Model 1010 is furnished optionally with a scale-of-100 or scale-of-256, and added scaling assemblies to make either a scale-of-1,000 or a scale-of-4,096 may be specified without appreciably affecting delivery.

A partial list of the standard features and modifications now available includes: Optional scale-of-100 or scale-of-256; plug-in input and diode-coupled scaling strips (binary or decade); resolving time less than 5 microseconds; inputs: G-M probe 9.25 volt sensitivity and external preamplifier; pulse height discriminator, adjustable; 2,500 v line and load regulated high voltage supply, etc.

(Continued on page 44A)

MARION . . . helps the OXY-CATALYST Mfg. Co.

MAKE EXHAUST GASES NON-POISONOUS



OCM manufactures a new type of Catalytic Exhaust which takes the place of the standard muffler . . . makes the exhaust gases of gasoline engines both non-poisonous and odorless. When applied to Fork Lift Trucks, for example, it makes them safe for inside use.

In developing the OCM Exhaust, a special type of ruggedized pyrometer was needed to withstand the deteriorating abuse to which OCM equipped machines are subjected. Critical accuracy, and exceptional dependability under extreme conditions of shock and vibration were necessary. Only Marion's new line of *ruggedized* instruments could meet these requirements.

This is why every OCM Exhaust now carries a Marion-made, thermocouple-operated pyrometer on the instrument panel. It indicates the temperature of the exhaust gases; tells when the unit is operating within the safe range. It also measures the air-fuel ratio while idling and so keeps a constant check on engine efficiency.

When you seek meters for unusual or standard applications, it will pay you to investigate Marion. Point for point, Marion invites comparison. Ask for catalog. There is no obligation. Marion Electrical Instrument Company, 407 Canal Street, Manchester, New Hampshire.

Canadian Representative: Astral Electric Company, 44 Danforth Road, Toronto, Ontario, Canada

Export Division: 458 Broadway, New York 13, U.S.A., Cables MORHANEX

marion meters

B&W Filter Manufacts*

- HIGH-PASS FILTERS
- LOW-PASS FILTERS
- BAND-PASS FILTERS
- BAND SUPPRESSION OR REJECTION FILTERS

For RF or audio filtering and line RF suppression . . . for harmonic attenuation and teletype communications . . . for single side band and telemetering equipment—these and many more are the uses to which B & W Filters are being applied daily. Time-tested and performance-proved, each of the filters listed above offers you a combination of accuracy and ruggedness that can't be beat in commercial equipment, military equipment . . . ANY EQUIPMENT.

That's why if your equipment requires filters—real filters built for day-in day-out dependability—B & W is the perfect answer. For details, write today to Barker & Williamson, Dept. PR-110.

*Manufacts = Manufacturing facts

BARKER & WILLIAMSON, INC.
237 Fairfield Avenue Upper Darby, Penna.

SECTION MEETINGS

BALTIMORE

"Color Television," by A. G. Jensen, Bell Telephone Laboratories; September 20, 1950.

DAYTON

"The Relation Between Science and Philosophy," by R. R. Baker, Faculty, University of Dayton; September 14, 1950.

DENVER

"VHF Amplification," by W. R. Bliss, Decimeter, Inc.; September 8, 1950.

HOUSTON

"Basic Systems of Color Television," and "Circuit Description of a Low-Distortion Class-B Amplifier," by F. H. McIntosh, McIntosh Engineering Laboratory; September 11, 1950.

INDIANAPOLIS

"Transmission Problems on Inter-city Television Networks," by M. E. Strieby, American Telephone and Telegraph Company; September 18, 1950.

LONDON

"Low Temperature Conductivity," by A. D. Misener, Faculty, University of Western Ontario; and Election of Officers; April 17, 1950.

"Frequency Conversion Equipment," by F. P. Kehoe, H.E.P.C. of Ontario; May 15, 1950.

LOUISVILLE

"Television Networks," by M. E. Strieby, American Telephone and Telegraph Company; September 19, 1950.

PITTSBURGH

"Bell System Inter-city Television Networks," by M. E. Strieby, American Telephone and Telegraph Company; September 11, 1950.

SAINT LOUIS

"Television Receiver Circuits," by B. S. Parmet, Motorola, Inc.; June 22, 1950.

TWIN CITIES

Inspection Trip of Radio Station WTC N-TV; May 25, 1950.

"The Linear Accelerator," by W. G. Shepherd, Faculty, University of Michigan; June 8, 1950.

WASHINGTON

"Measuring with the Electron," by L. Marton, National Bureau of Standards; September 11, 1950.

STUDENT BRANCH MEETINGS

UNIVERSITY OF KENTUCKY, IRE BRANCH

Election of Officers; September 21, 1950.

SOUTHERN METHODIST UNIVERSITY, IRE–AIEE BRANCH

"Electronic Protection Devices," by George Smith, Smith Detective Agency; August 31, 1950.
Film "Football Game"; September 14, 1950.

Just 60 SECONDS
from now . . .
. . . a finished
print!!!
. . . with the camera that brings a new speed and
efficiency to oscillograph-recording techniques

The DUMONT TYPE 297

Oscillograph-record Camera

You've just advanced the film after making an exposure. That starts the Polaroid-Land "packaged" developing process. And while you're waiting for its completion—in just 60 seconds—you can start the next exposure or set of exposures. With the Type 297, once you've snapped the shutter, its self-contained, 60-second, developing process lets you forget about the variables of the darkroom.

And with such special oscillographic features as simultaneous viewing and recording, an illuminated data-card, sturdy and easily attached mounting, and overall economy of the Polaroid film, Du Mont has added even greater meaning to this excitingly fast method for "printing" the oscillograph image.

SPECIFICATIONS

LENS—Du Mont-Wollensak f/2.8 or f/1.9, 75mm, coated.

SHUTTER — Wollensak Alphax; shutter speeds of 1/25, 1/50, 1/100 sec. Time and Bulb.

FOCUS—Fixed. May be adjusted for special oscillographic work.

WRITING SPEED—Writing rates of 3.5 in μsec. have been recorded consistently at 12,000 volts accelerating potential.

PRINT SIZE—3¼ x 4 ¼ in.—one, two, three, or more exposures per print.

IMAGE REDUCTION RATIO—2.25:1.

PHYSICAL SIZE—Length, 14⅝ in.; height, 10 in.; width, 6 in.

WEIGHT—12 lbs.

PRICE..... **$285.00** with f/2.8 lens
$355.00 with f/1.9 lens

Write for bulletin on photographic techniques.

. . . and for thrifty SINGLE-FRAME recording

THE DU MONT TYPE 296

Oscillograph-record Camera

The Type 296 is an inexpensive oscillograph-record camera, greatly improved for general-purpose application with any standard 5-inch cathode-ray oscillograph. It incorporates a compact, all-metal, 35mm camera, calibrated shutter and a high-quality f/2.8, 75mm, coated lens which increases its capability 57% over the Type 271-A which it supersedes. Construction is rugged and durable; operation simple and foolproof. The Type 296 weighs only 4½ lbs.

PRICE . . . $149.50

ALLEN B. DU MONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY

BALLANTINE

STILL THE FINEST
in
ELECTRONIC VOLTMETERS

Ballantine pioneered circuitry and manufacturing integrity assures the maximum in

SENSITIVITY • ACCURACY • STABILITY

- All models have a single easy-to-read logarithmic voltage scale and a uniform DB scale.
- The logarithmic scale assures the same accuracy at *all* points on the scale.
- Multipliers, decade amplifiers and shunts also available to extend range and usefulness of voltmeters.
- Each model may also be used as a wide-band amplifier.

MODEL 300

MODEL	FREQUENCY RANGE	VOLTAGE RANGE	INPUT IMPEDANCE	ACCURACY	PRICE
300	10 to 150,000 cycles	1 millivolt to 100 volts	1/2 meg. shunted by 30 mmfds.	2% up to 100 KC 3% above 100 KC	$200.
304	30 cycles to 5.5 megacycles	1 millivolt to 100 volts except below 5 K C where max. range is 1 volt	1 meg. shunted by 9 mmfds. on low ranges and 4 mmfds. on highest range	3% except 5% for frequencies under 100 cycles and over 3 megacycles and for voltages over 1 volt	$225.
305	Measures peak values of pulses as short as 3 microseconds with a repetition rate as low as 20 per sec. Also measures peak values for sine waves from 10 to 150,000 cps.	1 millivolt to 1000 volts Peak to Peak	2.2 megs. shunted by 8 mmfds. on high ranges and 15 mmfds. on low range	3% on sine waves 5% on pulses	$280.
310	10 cycles to 2 megacycles	100 microvolts to 100 volts	Same as Model 305	3% below 500 KC 5% above 500 KC	$225.

For further information, write for catalog.

BALLANTINE LABORATORIES, INC.

102 FANNY ROAD, BOONTON, N.J.

MEMBERSHIP

The following transfers and admissions were approved and will be effective as of November 1, 1950:

Transfer to Senior Member

Carlin, H. J., Microwave Research Institute, Polytechnic Institute of Brooklyn, 55 Johnson St., Brooklyn, N. Y.
Fonda-Bonardi, G., 1551 Tenth St., Manhattan Beach, Calif.
Heck, J. R., 1233 Ten Oaks Rd., Baltimore 27, Md.
Ide, J. M., U. S. Navy Underwater Sound Laboratory, New London, Conn.
Jensen, K. S., 1835 D 18 St., Los Alamos, N. Mex.
Krawitz, M., 1522 55 St., Brooklyn 18, N. Y.
Mabry, F. S., 38 Holmehurst Ave., Baltimore 28, Md.
McCoubrey, A. O., Westinghouse Research Laboratories, Ardmore Blvd., E. Pittsburgh, Pa.
Palin, E. L., 98 Donlea Dr., Leaside 17, Ont., Canada
Rodgers, J. A., Huntington Hills, Rochester 9, N. Y.
Wolfskill, J. R., 450 Long Branch Ave., Long Branch, N. J.
Zenner, R. E., 8732 Washington Ave., Hollywood, Ill.

Admission to Senior Member

Angell, A. G. H., Officers Mess, Royal Air Force, Manby, Louth, Lincs., England
Corrarino, C. W., 20-36 24 St., Long Island City 5, L. I., N. Y.
Erlandson, P. M., Southwest Research Institute, Box 2296, San Antonio, Tex.
Harris, C. M., Bell Telephone Laboratories, Inc., Murray Hill, N. J.
Winter, D. F., 3 Faculty Lane, St. Louis 5, Mo.

Transfer to Member

Bark, R. S., 2012½ N. 145, Seattle 33, Wash.
Boss, L. J., 6938 Hammond Ave., Dallas 10, Tex.
Day, J. L., 1614 Hilton Rd., Burlington, N. C.
Dickey, F. E., 947 Maple Ave., Schenectady, N. Y.
Ditkofsky, H., 4847 Esplanade Ave., Montreal 14, Que., Canada
Kerber, S. M., 164 Miramonte Dr., Fullerton, Calif
Mahoney, T. F., 1585 Great Plain Ave., Needham, Mass.
Sellers, G. W., Capehart Farnsworth Corp., Fort Wayne 1, Ind.
Simmons, J. M., Jr., Box 548, State College, N. Mex.
White, G. J., 69 Beresford Ave., Coventry, Warwickshire, England
Wood, R. V., Jr., 15 Linnaean St., Cambridge 38, Mass.

Admission to Member

Bellringer, C. C. E., 1460 Decarie Blvd., St. Laurent, Que., Canada
Borsody, B. F., 2317 N. 11 St., Arlington, Va.
Bothwell, F. E., Department of Electrical Engineering, Northwestern University, Evanston, Ill.
Bush, R. S., Radio Station KTHT, 4005 S. Travis, Houston 2, Tex.
Davis, J. N., 734 15 St., N.W., Washington 5, D. C.
Fields, M. H., 302 E. Iris St., Oxnard, Calif.
Horrigan, E. W., 36 Airport Rd., Knowle, Bristol 4, England
Johnson, H. S., 379 E. Buena Loma, Altadena, Calif
Kellner, R. L., Raytheon Manufacturing Company, Waltham 54, Mass.
Kiriloff, A., 446 W. 23 St., New York, N. Y.
Lindsey, H. K., 2290 Liliha St., Honolulu, T. H.
Lorentz, N. A., 3338 49 Loop, Sandia Base, N. Mex.
Pomper, V. H., 385 Putnam Ave., Cambridge 39, Mass.

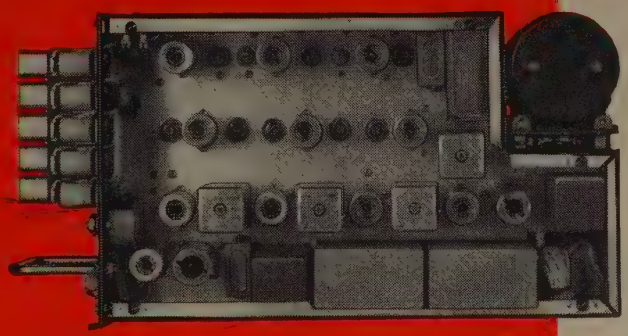
(Continued on page 42A)

51V-1 glideslope receiver, covers in place

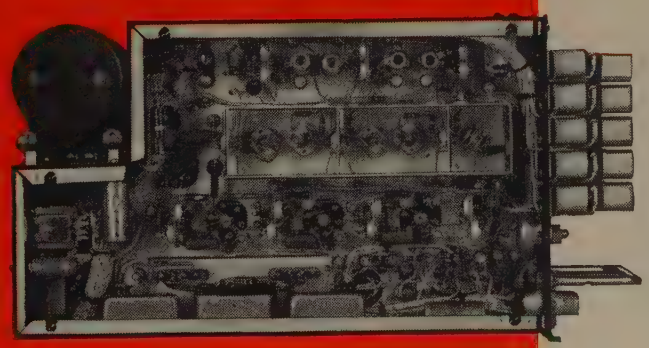
Glideslope Receiver

51V-1

. . . inside and out



Collins 51V-1 chassis (right side)



Collins 51V-1 chassis (left side)

THIS is the new Collins 51V-1 glideslope receiver for aircraft. Note the orderly design, and the accessibility of all tubes, components, and wiring.

The 51V-1 provides reception of 90/150 cps tone modulated glideslope signals on any of the twenty channels in the uhf range of 329-335 mc. This receiver together with Collins 51R navigation equipment will fulfill ILS receiving requirements for military, commercial and private aircraft. The design of the 51V-1 is based on "Glideslope Receiver Characteristics" issued by Aeronautical Radio, Inc., and on U. S. Airforce specifications.

Output circuits of the 51V-1 receiver feed standard ID-48ARN deviation indicators including flag alarm. By means of the flag alarm the pilot has a positive indication of the reliability of the glideslope signals and instrumentation.

The 51V-1 control circuits are integrated with the standardized R/θ channeling system with channel selection provided by means of a Collins 314U remote control unit.

More complete information, in the form of an illustrated bulletin, is yours on request.

IN AVIATION RADIO, IT'S...

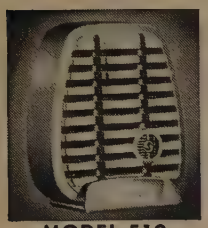
COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd St., NEW YORK 18 2700 West Olive Ave., BURBANK

"Controlled Reluctance"

MICROPHONES PROVED* TO BE THE FINE-QUALITY-ECONOMICAL ANSWER TO MANY MICROPHONE PROBLEMS



MODEL 510

The "HERCULES"—Here is a revolutionary new microphone unit that provides the ruggedness, the clear reproduction, and the high output long needed for Public Address, Communications, Recording *at an amazingly low price!*

List Price $14.50

MODEL 520

The "GREEN BULLET"—Specially designed to provide quality music and speech reproduction at moderate cost. A streamlined unit that lends itself to fine-quality, low-cost installations where durability is an important factor. Features high output, good response, high impedance without the need of a transformer.

List Price $17.50

MODEL 505C

The "RANGER"—Recommended for those applications where long lines are used and a rugged hand-held microphone is needed. Ideal for outdoor public address, mobile communications, hams, audience participation shows, etc. Designed for clear, crisp natural-voice response of high intelligibility. Has heavy-duty switch for push-to-talk operation.

List Price $27.50

MODEL 520SL

List Price $35.00

The "DISPATCHER"—Complete unit, includes Model 520 Microphone, A88A Grip-To-Talk Slide-To-Lock Switch, and S36A Desk Stand. Designed to handle the most severe field requirements of paging and dispatching systems. Ideal for police, railroad, taxicab, airport, bus, truck and all emergency communications work.

MODEL R5

CONTROLLED RELUCTANCE CARTRIDGE—Available for service installation. Ideal for replacement of crystal cartridges in Shure cases of Models 707A and 708 Series. Can also be used in most semi-directional microphones where space permits. Supplied with rubber mounting ring.

List Price $9.00

**Specific information provided on request.*

SHURE

Patented by Shure Brothers, Inc.

SHURE BROTHERS, Inc.

Microphones and Acoustic Devices

225 West Huron Street, Chicago 10, Ill. • Cable Address: SHUREMICRO

MEMBERSHIP

(Continued from page 40A)

Raits, E. J., 210 N. W. First Ave., Mineral Wells, Tex.
Sagert, H. T., Rm. 920, LaSalle Street Sta., Chicago 5, Ill.
Sedlacek, W. C., 628 Iris St., Oxnard, Calif.
Shields, R. R., Box 416, Emporium, Pa.
Simpson, C. L., Rich Valley Rd., Emporium, Pa.
Spear, R. B., 510 E. Hill St., Brownfield, Tex.
Staras, H., 617 S. Fillmore St., Arlington, Va.
Sullivan, H. J., 348 Lincoln Ave., Cranford, N. J.
Watson, J. T., 14 S. Euclid, Indianapolis, Ind.

The following admissions to the Associate grade were approved to be effective as of October 1, 1950:

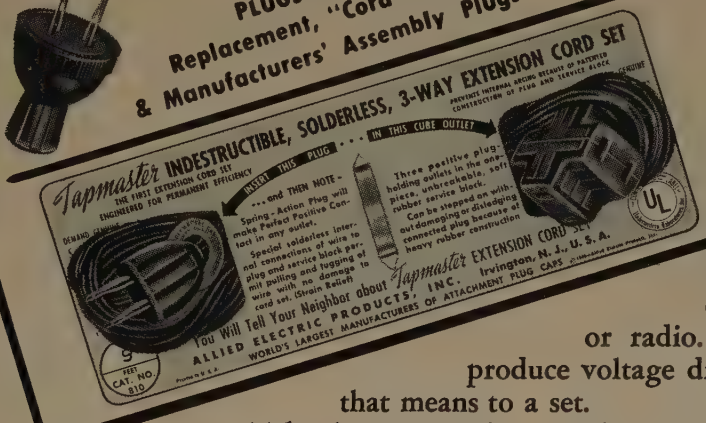
Agnew, N. F., 549 Brushton Ave., Pittsburgh 21, Pa.
Aubey, L. J., Box 89, Beaumont, Tex.
Blair, H. A., Jr., 130 Wilson Dr., Pittsburgh 21, Pa.
Blake, C., 67 N. Main St., Orono, Me.
Blumkin, R., 55 Winthrop St., Brooklyn 25, N. Y.
Bokros, P., 3214 W. Columbia Ave., Philadelphia 21, Pa.
Bouffiou, C. L., 900 Riverside Dr., Aberdeen, Wash.
Bryant, C. S., 47 Northwest 94 St., Miami 38, Fla.
Caffrey, T. J., Clifford House, 2552 Clifford, Detroit 1, Mich.
Camillo, C., 4358 S. Artesian Ave., Chicago 32, Ill.
Chittenden, W. R., 3229 E. Manoa Rd., Honolulu, T. H.
Clarke, H. W., 504 32 St., Saskatoon, Sask., Canada
DeGarmo, A. V., Jr., 1257 W. Forest, Detroit 1, Mich.
Erickson, D. L., 4726 N. Rockwell St., Chicago 25, Ill.
Fahnestock, J. D., 52 Corncrib Lane, Levittown, L. I., N. Y.
Finkel, A., 338 Madison St., N.W., Washington 11, D. C.
Green, S., 59 Bay St., Brooklyn 14, N. Y.
Halle, C., 2863 Mayfield Rd., Cleveland Heights, Ohio
Hammett, T. F., 139 Bedford St., Lexington 73, Mass.
Harnett, G. H., R.F.D. 4, Bloominggrove Tpke., Newburgh, N. Y.
Havens, A. C. B., 160 W. 73 St., New York 23, N. Y.
Herbig, A. J., 150-25 Third Ave., Whitestone, L. I., N. Y.
Howe, W. F., 513 Military Dr., Coeurd'Alene, Idaho
Hull, C. J., Old Powerville Rd., Boonton, N. J.
Johnson, D. A., 627 E. 19 St., Minneapolis 4, Minn.
Kurkjian, E., 1406 Hickory St., Grand Prairie, Tex.
Mann, R. W., 602 W. Cunningham Ave., Urbana, Ill.
Mason, R. F., 25100 Fisher Ave., Euclid, Ohio
Merrill, J. A., 4028 Los Feliz Blvd., 10, Los Angeles 27, Calif.
Mohr, D. B., 375 RCN Sqdn., APO 937, c/o Postmaster, Seattle, Wash.
Moore, C. C., Jr., 208 Via Alcance, Palos Verdes Estates, Calif.
Morley, J. E., 3 Morley Rd., Twickenham, Middlesex, England
Nagy, W. Z., 179 Davis Ave., Staten Island 10, N. Y.
Noble, J. S., Radio Propagation Station, Navy 117, FPO, New York, N. Y.
Palmer, M. V., 4002 Fruit Valley Rd., Vancouver, Wash.
Sikes, R. E., 2012 Tenth Rd., S., Arlington 4, Va.
Sindelar, E. E., 2825 Portman Ave., Cleveland, Ohio
Sirinsky, R., 3329 Ridge Ave., Philadelphia, Pa.
Smollett, R. J., 656 W. Burnside, Caro, Mich.
Snider, D. A., 221 Harriet St., Alton, Ill.
Stevens, H. V., 63 Edson, Buffalo 10, N. Y.
Sweeney, P. M., 3826 N.E. 34 Ave., Portland 13, Ore.
Triantafellow, W., 120–21 142 St., South Ozone Park 20, L. I., N. Y.

(Continued on page 44A)

YOUR CONNECTIONS ARE IMPORTANT!

Spring Action
PLUGS & CAPS
Replacement, "Cord Clamp"
& Manufacturers' Assembly Plugs

Tapmaster
CUBE TAPS
One-Piece Rubber
and Bakelite


Tapmaster INDESTRUCTIBLE, SOLDERLESS, 3-WAY EXTENSION CORD SET
INSERT THIS PLUG
IN THIS CUBE OUTLET
...and THEN NOTE -
Spring-Action Plug will make Perfect Positive Contact in any outlet.
Special solderless internal connections of wire to plug and service block permit pulling and tugging of wire with no damage to cord set. (Strain Relief)
Three positive plug-holding outlets in the one-piece, unbreakable, soft rubber service block. Can be stepped on without damaging or dislodging connected plug because of heavy rubber construction
Tapmaster EXTENSION CORD SET
Irvington, N. J., U. S. A.
You Will Tell Your Neighbor about
ALLIED ELECTRIC PRODUCTS, INC.
WORLD'S LARGEST MANUFACTURERS OF ATTACHMENT PLUG CAPS

Tapmaster
EXTENSION CORD SETS
3-Way & Single-Outlet Types
6', 9', 12', and 15' Lengths

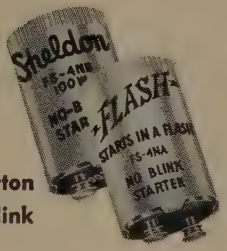
Poor contact between line plug and wall outlet can cause a heap of trouble in a T-V set or radio. A defective plug or worn outlet can produce voltage drop and arcing . . . and you know what that means to a set.

Take that *ounce of prevention!* Replace the line plug with a genuine Spring-Action Replacement Plug—the sure way to be sure of positive contact even in a worn outlet. If you need a multiple outlet, use a *Tapmaster* Cube Tap. Or, if the line cord needs lengthening, use a Tapmaster Extension Cord Set. These products have *Spring-Action* Blades and Internal Contacts. With them, you'll get *good connections* any place, all the time.

MR. SERVICEMAN—Save yourself unnecessary service calls. Carry these three connections in your kit. Your jobber can supply them to you.

YOU CAN DEPEND ON THESE OTHER ALLIED-SHELDON PRODUCTS

-FLASH-
Sheldon
FLUORESCENT STARTERS
World's Largest Line—
Automatic Cutout . . . Push-Button
. . . Multi-Purpose . . . No-Blink
. . . Standard Types



Sheldon
2, 6 and 15 Amps.
RECTIFIER BULBS

Sheldon
ALUMINIZED REFLECTOR LAMPS
Infra-Red, Flood, Spot, Clear,
Photoflood, Photospot, 2,000
Hour & Outdoor Pyrex Types

WRITE FOR YOUR COPY OF THE NEW ALLIED-SHELDON CATALOG

DELIVERY ON ALL ITEMS ON THIS PAGE — *Fair to Middlin'!*

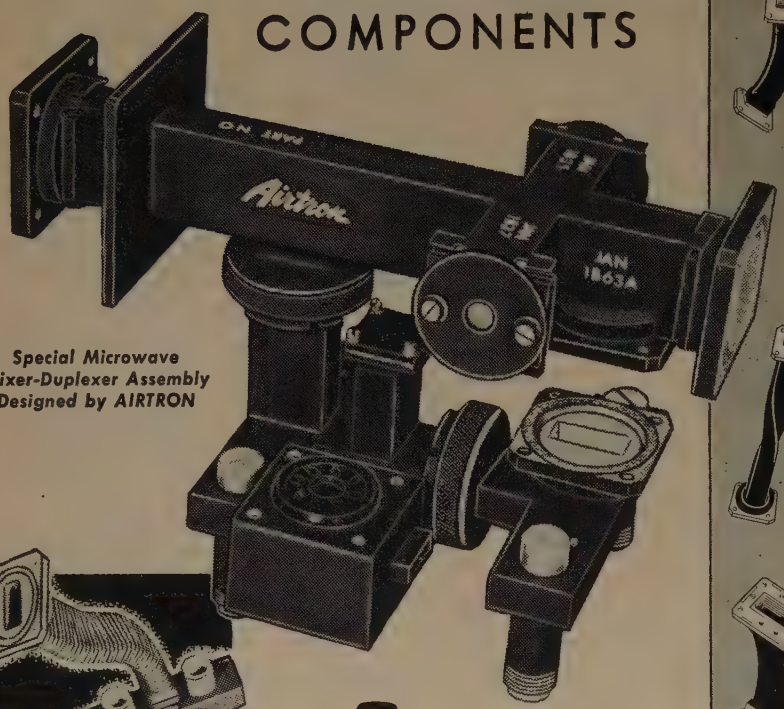
ALLIED ELECTRIC PRODUCTS INC.
68-98 Coit Street, Irvington 11, N. J.
Branch Offices & Warehouses: CHICAGO 7, ILL., 426 S. Clinton St. — LOS ANGELES 26, CAL., 1755 Glendale Blvd.

Airtron DESIGNS AND PRODUCES

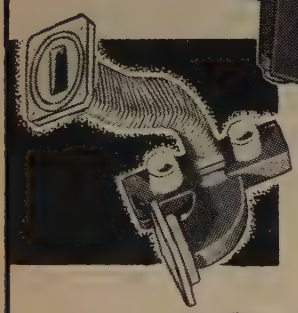
Flexible and *Rigid*

WAVEGUIDE

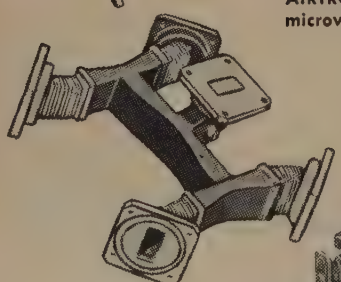
COMPONENTS

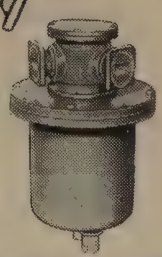


Special Microwave Mixer-Duplexer Assembly Designed by AIRTRON



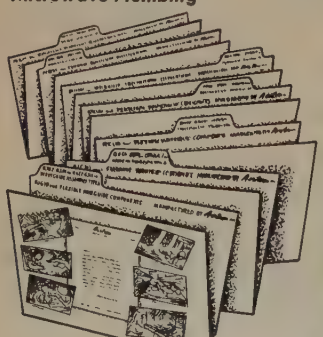
From the smallest waveguide component to complete transmission systems... from the first "doodle" memo or blueprint to the finished precision product . . . make AIRTRON your FIRST source for all types of microwave plumbing. Unique in background, technical savvy, plant facilities and the WILL to SERVE, this organization is prepared to engineer and manufacture your staple or special requirements in:

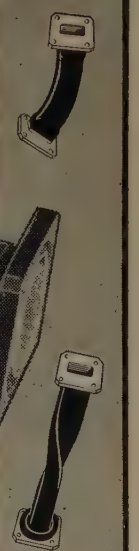


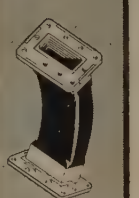


Mixers
Duplexer Assemblies
Magic Tees
Waveguide Switches
Elbow Bends
Elbow Miters
Twisted Sections
Rigid Twists
Choke Fittings
Flexible Waveguides
Straight Section
Rotary Joints

Send for AIRTRON Engineering Data on Microwave Plumbing







Airtron INC.

105 East Elizabeth Ave., Linden, New Jersey

BRANCH OFFICES

Baltimore Los Angeles New York
Boston St. Louis Dallas Dayton

(Continued from page 42A)

Vergona, A. J., 45 E. Bataan Ave., Clairton, Pa.
Vernon, H. J., 623 W. Surf St., Chicago, Ill.
Vogel, C. I., 1950 W. Fort St., Detroit 16, Mich.
Washeim, W. G., 4603 Snow Rd., Parma, Ohio
Wehrman, R. B., 624 Rockford Ave., Dayton 5, Ohio
White, R. A., 913 N. Frederic, Burbank, Calif.
Zilles, F. J., 918 Agatite, Chicago 40, Ill.

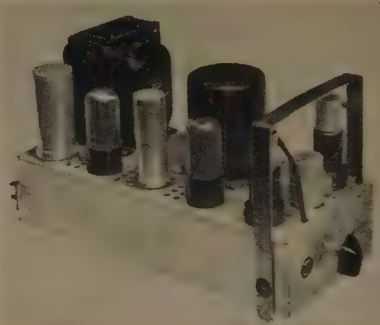
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 30A)

Versatile Line Amplifier

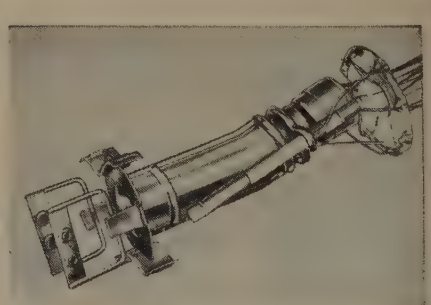
A new Type MI-12160 plug-in line amplifier with self-contained power supply is available from **Radio Corp. of America, RCA Victor Div.,** Camden, N. J.



It may be used as a master mixer for supplying zero level to a telephone line, a line amplifier capable of operating from a telephone line, a driver amplifier supplying driving voltage for up to 500 power amplifiers, a monitor amplifier supplying two watts of audio power to a speaker, or a bridging amplifier for bridging a low impedance line. The instrument provides excellent frequency response from 30 to 15,000 cps with low distortion.

New Bent-Gun Features Uniform Screen Focus

Uniform focus over the entire usable screen area is now attained by means of a new bent-gun announced by the **Cathode-**



Ray Tube Div., Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.

(Continued on page 48A)

The one millionth Teletron recently rolled off the production line. It was all in the day's work for Du Mont's vast Allwood plant geared to over a million TV picture tubes a year. Yet that tube established a unique record, because it represented the one millionth BIG TUBE. No other manufacturer has made that many BIG TUBES.

Ever since 1939 when Du Mont introduced the first commercial television set with its 14″ Teletron, Du Mont has pioneered BIG TV TUBES. While others were offering 7″ and 10″ tubes, Du Mont was satisfied with nothing less than 12″. Even as early as 1939, Du Mont made 20″ Teletrons. Since then the public and industry have followed the Du Mont lead, but Du Mont remains in the lead with still larger tubes climaxed by the 30″ Teletron available shortly.

Obviously, in BIG TUBES the BIG NAME is DU MONT.

DU MONT

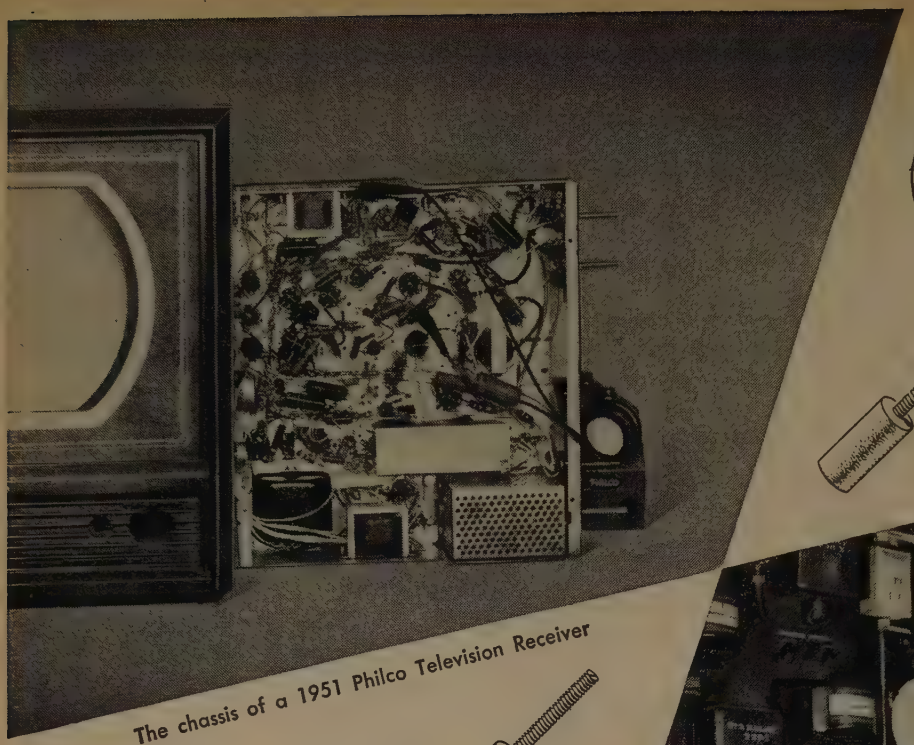
Teletrons*

First with the Finest in Television

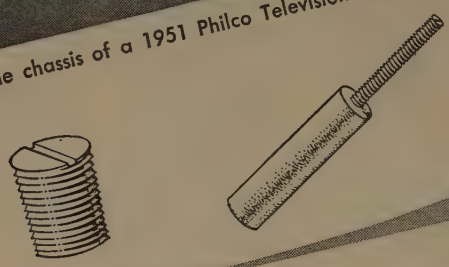
Literature on request *Trade-Mark

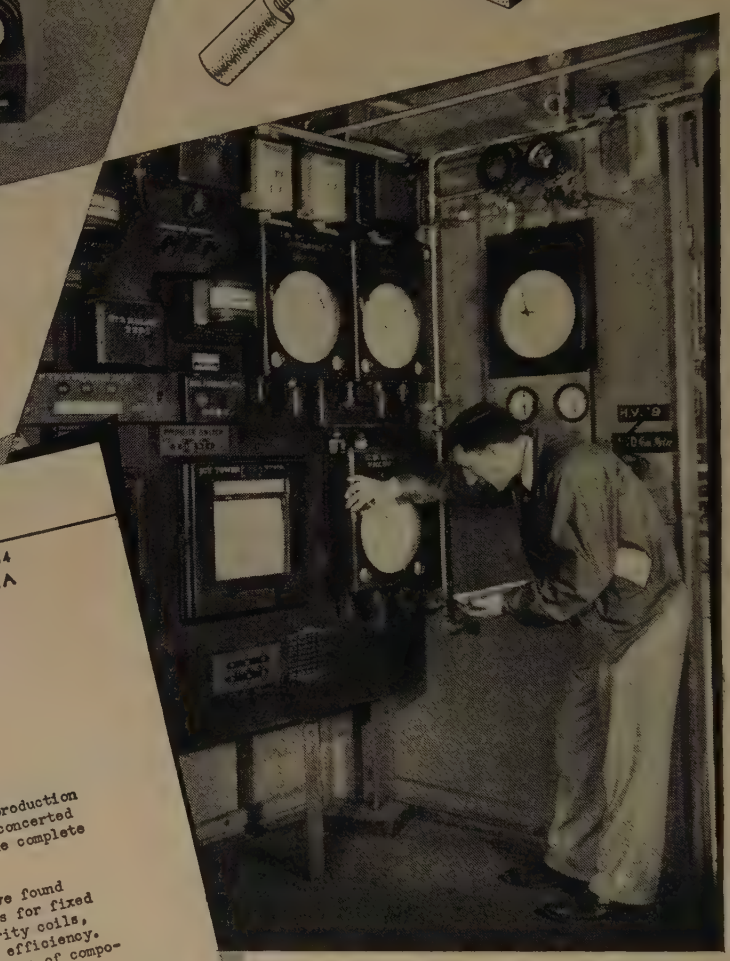
ALLEN B. DU MONT LABORATORIES, INC.

TUBE DIVISION • CLIFTON, N. J.



The chassis of a 1951 Philco Television Receiver





In the making of G A & F Carbonyl Iron Powders only the strictest methods of Quality Control are observed

PHILCO CORPORATION

PHILADELPHIA 34
PENNSYLVANIA

September 5, 1950

Mr. T. R. Moore, Sales Manager
Antara Products - General Aniline & Film Corporation
444 Madison Avenue
New York 22, N. Y.

Dear Mr. Moore:

For the past two years Philco has tremendously increased its production of television receivers, and at the same time we have made a concerted drive to improve the quality of all components, as well as the complete receivers.

In line with this successful Quality Control program, we have found that your Carbonyl Iron Powders, used in powdered iron cores for fixed and variable inductances, in such parts as width and linearity coils, IF transformers and tuner coils, result in greater circuit efficiency. At the same time, it has also been possible to reduce the size of components which incorporated powdered iron.

Because of these advantages, reduced size and increased efficiency of components, as well as a uniformly high standard of quality, your Carbonyl Iron Powders have aided us in keeping the quality of Philco television receivers at the highest level. This has been particularly important because we have stepped up quantity of production so greatly along with quality. We are aiming at manufacturing more than 1,000,000 Philco television receivers in 1950.

Very truly yours,

PHILCO CORPORATION

T. M. Craig
Director of Engineering
Electronics Division

G A & F® Carbonyl

SIZES REDUCED . . . EFFICIENCY INCREASED

for components of PHILCO Television Receivers through use of

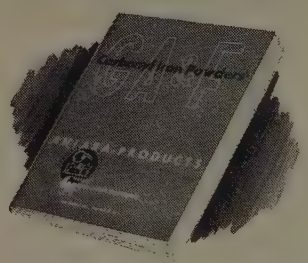
CARBONYL IRON POWDERS

PHILCO Television Receivers are produced under rigid, scientific methods of Quality Control . . . So are G A & F Carbonyl Iron Powders . . . It was all but inevitable that the combination would produce components of high efficiency and top performance.

However, Philco was not blindly worshipping an abstract ideal. *Reduced sizes* became a second, highly desirable result. Third, as leading core makers have testified, it *costs less* to work with quality materials—such as G A & F Carbonyl Iron Powders.

The savings and the gains are both more numerous and more important than are here indicated. Let us send you the book described below . . . Ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance of the equipment you manufacture. It will cost you nothing to get the facts.

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Department 51.



ANTARA® PRODUCTS

DIVISION OF

GENERAL DYESTUFF CORPORATION

435 HUDSON STREET • NEW YORK 14, NEW YORK

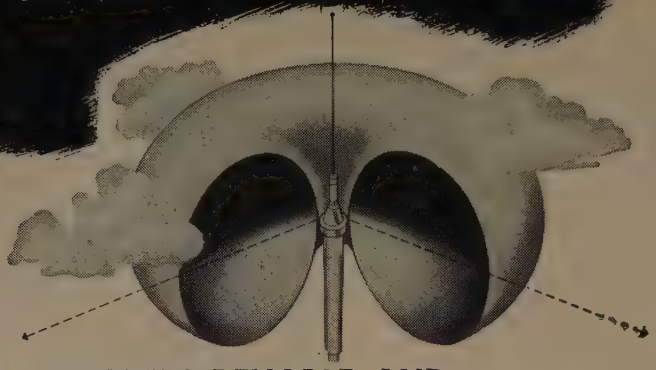
BRANCHES

Boston • Providence • Philadelphia • Charlotte, N. C. • Chicago • Portland, Ore. • San Francisco • Oakland

Iron Powders . . .

MEMBER mpa METAL POWDER ASSOCIATION

It's CP for COAXIAL HALF-WAVE DIPOLE ANTENNAS for two-way mobile service



PROVEN RELIABLE AND EFFECTIVE OVER THE YEARS

CP Antennas use one of the most effective — and elemental — forms of antennas serving radio communications. Simple physically and electrically, CP Antennas have earned a reputation for reliability.

CP Coaxial Antennas are ruggedly constructed of selected materials to give satisfactory commercial service under severe operating conditions. They are recommended for both transmission and reception. Power handling capacity is limited only by the rating of the feed line. All antennas feature rust-proof construction throughout with necessary accessories for simple, positive installation.

Ask for your copy of CP Bulletin 106

This new bulletin, compiled by the engineering staff of Communication Products, provides complete data on CP antenna construction, as well as detailed specifications and operational information. Fully illustrated with photographs and schematic sketches. Call or write CP, now, for Bulletin 106 or literature on any of the products listed below.

YOU CAN DEPEND ON THESE CP PRODUCTS

- ✓ LO-LOSS SWITCHES
- ✓ TEFLON TRANSMISSION LINE
- ✓ AUTO-DRYAIRE DEHYDRATORS
- ✓ COAXIAL DIPOLE ANTENNAS
- ✓ TOWER HARDWARE

Communication Products Company, Inc.

KEYPORT CP NEW JERSEY

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 44A)

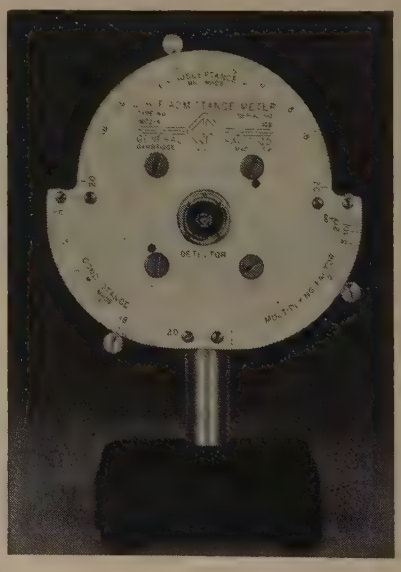
A higher degree of prefocusing in the new gun passes a smaller diameter beam bundle through the deflection field. This reduces spot distortion and results in uniform focus over the entire usable screen.

A new grid-cathode assembly makes it possible to obtain this greater prefocusing without increasing the over-all length of the tube. An improved bulb spacer simplifies gun centering and insures proper anode contact. Stray emission at higher voltages is minimized by rounding the corners of pertinent gun components.

These latest developments, which retain the advantage of employing a single beam-bending magnet, are being incorporated in all Du Mont Telectrons.

UHF Admittance Meter

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. has developed a new Type 1602-A uhf admittance meter, a null-type instrument, based on coaxial-line techniques for making impedance measurements at ultra-high frequencies. It is simple in operation, and just as easy to use as a low-frequency bridge. It balances in the same manner as a bridge and indicates conductance and susceptance on direct-reading dials, calibrations of which are independent of frequency; and the null settings for both components are completely independent.



The meter can be used to measure conductances, and susceptances of either sign, from one millimho to 400 millimhos (1,000 ohms to 2.5 ohms) over a frequency range from 70 to 1,000 Mc, thus covering both the present and the proposed new uhf television bands. Accuracy is ±5 per cent. The admittance components can be easily converted to impedance, if desired, by using a Smith chart or Smith-chart slide rule.

(Continued on page 65A)

NEW INDICATOR ION TRAP

Now in all Rauland Tubes

The response to Rauland's new Indicator Ion Trap, after its introduction in the 12LP4-A, has been so enthusiastic that this feature has now been incorporated in all Rauland tubes—as a standard feature of the new Rauland Tilted Offset Gun.

In the field or on the assembly line, this new Indicator Ion Trap reduces Ion Trap Magnet adjustment time to a matter of seconds, eliminates mirrors and guesswork, and assures accuracy of magnet adjustment. It can increase profits for every service man and service dealer—and at the same time assure better customer satisfaction.

A bright green glow on the anode of the picture tube signals when adjustment is incorrect. Correct adjustment is made instantly, by moving the magnet until the glow is extinguished or reduced to minimum.

Only Rauland offers this advanced feature—one of a half-dozen important post-war developments from Rauland.

RAULAND

The first to introduce commercially these popular features:

- Tilted Offset Gun
- Indicator Ion Trap
- Luxide (Black) Screen
- Reflection-Proof Screen
- Aluminized Tube

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE • CHICAGO 41, ILLINOIS

The W. L. MAXSON

CORPORATION

IS

SEEKING

Outstanding

ENGINEERS

AND

PHYSICISTS

with

AMBITION

TO

FURTHER

PRESENT

STANDING

Immediately

Minimum Requirements are:

1. Five to ten years experience in advanced electronic research and development
2. Outstanding record of ingenuity
3. Ph.D., M.S. or equivalent

Please send résumé and salary requirements to:

The W. L. MAXSON

CORPORATION

460 W. 34th St.

New York 1, N.Y.

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.

1 East 79th St., New York 21, N.Y.

CIRCUITS ENGINEER

Rapidly expanding company in instrumentation field has opening for senior engineer. Prefer man with masters degree and 4 or more years of experience in design of pulsing circuits, VHF and UHF. Excellent opportunity for man who can meet requirements. Location Brooklyn. Send complete resume to Box 623.

PHYSICIST

Physicist for fundamental electron tube research. Should be familiar with techniques of producing photo-electric, secondary emissive and fluorescent screens, experience with electron-optics, physical optics and solid state physics an advantage. Box 624.

SALESMAN

Salesman to organize and promote sales of high quality radio resistors now being produced by a company well established in radio and electrical component industry. Give summary of experience and availability in reply. Box 625.

ASSISTANT PROFESSOR AND JUNIOR INSTRUCTOR

Strong eastern college has opening for Assistant Professor and Instructor in electrical engineering. Master of Science in electrical engineering is required, and industrial experience is desirable. Send resume of qualifications, references and salary required. Box 626.

PHYSICISTS AND ENGINEERS

Cornell Aeronautical Laboratory, an affiliate of Cornell University, has permanent positions open in fields of pure and applied physics for men of project engineer caliber with advanced degrees and experience in physics, applied mathematics, electronics, and mechanical instrument design. The position of our laboratory is between those of universities and commercial research institutes, and combines, we believe, many of the traditional advantages of both. Inquiries confidential; address Mr. Nathaniel Stimson, Dept. R, Cornell Aeronautical Lab., P.O. Box 235, Buffalo 21, N.Y.

ELECTRONIC PHYSICIST

Electronic physicist for research and development work on instrumentation problems with major petroleum refiner. Degree in physics essential, M.S. or Ph.D. preferred. Must have a minimum of 5 years research experience on a variety of electronic problems and demonstrated ability to develop new and ingenious electronic devices. Age 28-40. Location Chicago. Salary dependent upon training and experience. Reply in confidence giving full details to Box 627.

(Continued on page 52A)

ELECTRONICS TECHNICIANS WANTED

The RCA Service Company, Inc., a Radio Corporation of America subsidiary, needs qualified electronics technicians for U. S. and overseas assignments. Candidates must be of good character and qualified in the installation or maintenance of RADAR or COMMUNICATIONS equipment or TELEVISION receivers. No age limits, but must have at least three years of practical experience.

RCA Service Company offers comprehensive Company-paid hospitalization, accident and life insurance programs; paid vacations and holidays; periodic review for salary increases; and opportunity to obtain permanent position in our national and international service organization, engaged in the installation and maintenance of AM, FM, and TV transmitters, electronic inspection devices, electron microscopes, theatre and home television, r-f heating equipment, mobile and microwave communications systems, and similar electronic equipment.

Base pay, overseas bonus, payments for actual living and other expenses, and benefits mentioned above add up to $7,000 per year to start for overseas assignments, with periodic review of base salary thereafter. Openings also available at proportionately higher salaries for specially qualified technicians with supervisory ability.

Qualified technicians seeking an advantageous connection with a well-established company, having a broad-based, permanent peacetime and wartime service program, write to:

Mr. G. H. Metz,
Personnel Manager,
RCA Service Company, Inc.,
Camden 2, New Jersey.

Potter INSTRUMENT COMPANY

ANNOUNCES

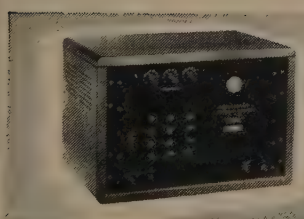
INCREASED MANUFACTURING & DEVELOPMENT FACILITIES

YOU, OUR CUSTOMERS, have been presenting us with problems which require skill not only in electronic circuitry but in unique mechanical design as well.

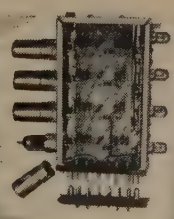
In solving many of your problems, we have found it necessary to think in terms of the most compatible combination of electronics and mechanics. Many companies are expert in one or the other of these fields, but a company which is skilled in both is rather rare. Realizing this fact, we have made a greater effort to mold our organization and facilities accordingly. Our latest step in this direction has been to construct a new plant with complete machine shop facilities and increased manufacturing space. Another goal for which we have been striving is circuit simplification. Our philosophy for the last eight years has been to design equipment with the fewest number of tubes and components without compromising on dependability. The result of this philosophy is evident in the basic 4-lamp Potter Decade and in new equipment designs yet to be announced. These include simplified and economic arithmetic units, multi-purpose shift registers, storage devices, photoelectric readers, tape handlers and a radically new high speed line-at-a-time printer. If you are concerned with problems in these fields write to Dept. 5-C for additional information.

- High Speed Electronic Counters and Scalers
- Precision Chronograph and Timing Instruments
- Frequency Measurement Counters
- Electronic Digital Computers and Memory Devices
- High Speed Printer Units and Data Handling Equipment

POTTER INSTRUMENT COMPANY
INCORPORATED
115 CUTTER MILL ROAD, GREAT NECK, NEW YORK

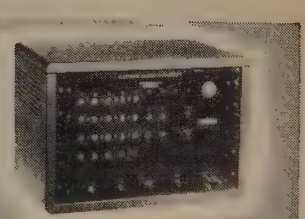


PREDETERMINED COUNTERS feature counting rates to 60,000 per minute, absolute accuracy, instantaneous automatic reset, simple dial selection of count.



DECADE COUNTER provides direct decimal read-out with the simplest most reliable decade circuit made. Finest components, superb construction.

TIME STUDY COMPUTOR—custom designed to compute operation waiting time for payroll applications, etc.; also computes most efficient combination of man and machines.



1.6 MC COUNTER CHRONOGRAPH with high resolution and accuracy (1/1,600,000 second). Indicates intervals up to 1 second. Dependable, stable, no adjustments required.

ELECTRONIC ENGINEERS

BENDIX RADIO DIVISION

Bendix Aviation Corporation

PRODUCTION DESIGN RESEARCH

Bendix Radio Division, a leader in the field of high quality radar and communications equipment, has positions for engineers experienced in the design and development, for production, of radio and radar equipment or electronic research.

Positions are available at all salary levels.

Good advancement opportunities, air-conditioned plant in suburban location, excellently equipped laboratories, technical library, large experimental engineering model shop.

Housing and rentals in Baltimore are plentiful.

Interviews will be held in Baltimore, Chicago and New York. Please send resume of experience promptly to:

MR. W. L. WEBB, *Director* Engineering and Research
BENDIX RADIO DIVISION
Bendix Aviation Corporation • Baltimore 4, Maryland

Bachelors, Masters, Ph.D.'s in PHYSICS or E.E.; Experienced Electronic Engineers; Supervisory Personnel for vital war work.

OPPORTUNITY ON LONG ISLAND

for research minded engineers

Offers attractive working conditions, salary commensurate with experience, access to graduate schools, first-rate research and development facilities; other advantages.

Projects underway in fields of microwave receivers, transmitters, antennas; radar, air traffic control; servos, motor control systems; general electronics.

Write PERSONNEL MANAGER

Airborne Instruments Laboratory
INCORPORATED

160 OLD COUNTRY ROAD · MINEOLA, N.Y.

ENGINEERING OPPORTUNITIES

MODERN LABORATORIES IN LOS ANGELES AREA

Unusual opportunity for Senior men with degree and a background of proven accomplishment.

ELECTRONIC ENGINEERS
PHYSICISTS-CIRCUITRY
PHYSICISTS-ANALYSIS
PHYSICISTS-OPTICS
SERVOMECHANISMS ENGINEERS
ELECTRO MECHANICAL DESIGNERS
MECHANICAL DESIGNERS

Long term program of research and development.

Please do not answer unless you meet the above requirements.

RESEARCH AND DEVELOPMENT LABORATORIES

Hughes Aircraft Company
CULVER CITY, CALIFORNIA

POSITIONS OPEN

(Continued from page 50A)

ENGINEER

Well known German radio manufacturer has immediate opening for engineer with design and development experience in FM-TV equipment. Factory situated in mountainous part of southern Germany (U.S. Zone) with pleasant living conditions (summer and winter sports). German language desirable. Please write to Z.G. 931—Annoncen-Expedition Carl Gabler, GMBH, Munich, Germany.

PROJECT ENGINEERS

Five years or more experience in charge of design and development of radio and communication equipment. Must be a graduate of a credited engineering school. Well equipped laboratory in modern radio and television plant, with excellent opportunities for advancement. Send resume of qualifications to Mr. S. F. Cascio, Personnel Director, Hallicrafters Company, 4401 West Fifth Avenue, Chicago 24, Illinois.

ENGINEERS

A very large vacuum tube and cathode ray tube manufacturer has attractive openings for experienced vacuum tube engineers. It will be to your benefit to investigate these possibilities. Please write to Box 628.

SENIOR ELECTRONIC ENGINEER

Opportunity with manufacturer of electronic electro-mechanical and radiation instruments. Requirements: 5 years experience in design and development of pulse circuit computers, nuclear instrumentation or video circuits required. Manufacturing or production experience desirable. Send complete resumes and salary requirement to: Berkeley Scientific Company, P.O. Box 1826, Richmond, Calif.

PRODUCTION ENGINEER

Opportunity with manufacturer of electronic, electro-mechanical and radiation instruments. Requirements: 5-10 years experience as electronic and mechanical instrument production engineer in small lot production. Thorough electronic theory grounding. Send complete resume and salary requirements to Berkeley Scientific Co., P.O. Box 1826, Richmond, Calif.

ELECTRICAL ENGINEER

Graduate with experience in design and production technique of specialized electronic tubes other than high production transmitting and receiving types. Bendix Aviation Corp., Kansas City Division, P.O. Box 1159, Kansas City, Missouri.

ELECTRONIC ENGINEER

Excellent opportunities are offered by one of the leading concerns in the electronic computer field to engineers with development or design experience in video and pulse circuitry or test and maintenance experience in the radar, television or computer fields. Send complete information to Personnel Dept., Eckert-Mauchly Computer Corporation, 3747 Ridge Avenue, Philadelphia 32, Pa.

ELECTRONIC ENGINEER

Senior graduate engineer with at least 10 years experience in receiver design.

(Continued from page 54A)

ANOTHER *New* RAYTHEON SUBMINIATURE

THE CK5829 TWIN DIODE

TO PROVIDE YOU WITH

1. **High perveance (performance compares favorably with that of the larger 6AL5)**
2. **Low heater current (150 ma.); half as much as the 6AL5**
3. **Moderate cost**

RAYTHEON *Subminiature Tubes* have long been standard throughout the world. More of them are in commercial use than all other makes combined. They assure *greater product salability* due to size reduction — *greater convenience* because they fit standard sockets or can be soldered or welded into the circuit, and because over half a million are available from stock; over 300 Raytheon Tube Distributors are at your service — *greater dependability*, backed by unsurpassed technical resources and a dozen years of production and application experience with long-life Subminiature Tubes.

→ NEW TYPES

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	TYPICAL OPERATING CONDITIONS Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
→ CK626CX	Half Wave Rectifier	0.400	1.75	6.3	300				45	Inverse peak 850 volts		
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	Rk = 200
CK5703/CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			Rk = 220
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			Rk = 500
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	−2.0
→ CK5829	Similar to 6AL5	0.300x0.400	1.5	6.3	150			117ac	5.0 per section			
FILAMENT TYPES												
1AD4	Shielded RF Pentode	0.300x0.400	1.5	1.25	100	2000		45.0	2.8	45.0	0.8	Rg = 2meg
2E31-32	Shielded RF Pentode for pocket radio	0.300x0.400	1.56	1.25	50	500		22.5	0.4	22.5	0.3	0
2E35-36	Output Pentode for pocket radio	0.290x0.390	1.56	1.25	30		6	45.0	0.45	45.0	0.11	−1.25
2E41-42	Diode Pentode for pocket radio	0.290x0.390	1.56	1.25	30	375		22.5	0.35	22.5	0.12	0
2G21-22	Triode Heptode for pocket radio	0.300x0.400	1.56	1.25	50	60 conv. cond		22.5	0.20	22.5	0.30	
RK61	Gas Triode, Exp. Radio Control	0.550	1.81	1.4	50			45.0	1.5	Special Circuit		
CK510AX	Double Space Charge Tetrode Amplifier	0.285x0.400	1.25	0.625	50	150† both units		45.0	0.06			0
CK512AX	Low microphonic voltage amplifier	0.285x0.385	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	−0.625
CK522AX	Output Pentode 20 ma. filament	0.285x0.385	1.5	1.25	20	450	1.2	22.5	0.30	22.5	0.08	0
CK524AX	Output Pentode	0.285x0.385	1.5	1.25	30	300	2.2	15.0	0.45	15.0	0.125	−1.75
CK525AX	Output Pentode	0.285x0.385	1.5	1.25	20	325	2.2	22.5	0.25	22.5	0.06	−1.2
CK526AX	Output Pentode	0.285x0.385	1.5	1.25	20	400	3.75	22.5	0.45	22.5	0.12	−1.5
CK527AX	Output Pentode 15 ma. filament	0.285x0.385	1.5	1.25	15	225	0.75	22.5	0.10	22.5	0.025	0
CK529AX	Shielded Output Pentode	0.290x0.390	1.515	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK533AX	Output Pentode	0.285x0.385	1.5	1.25	15	400	1.8	22.5	0.36	22.5	0.09	0
CK534AX	Voltage Amplifier	0.285x0.385	1.25	0.625	15	30†		15.0	0.0047	15.0	0.0014	−0.625
CK535AX	Output Pentode	0.285x0.385	1.5	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK551AXA	Diode Pentode	0.300x0.400	1.56	1.25	30	235		22.5	0.17	22.5	0.043	0
CK553AXA	RF Pentode	0.300x0.400	1.56	1.25	50	550		22.5	0.42	22.5	0.13	0
CK571AX	10 ma. filament Electrometer Tube, $I_g = 2 \times 10^{-15}$ amps. max.	0.285x0.400	1.5	1.25	10	1.6†		10.5	0.20	Triode Conn.		−3.0
CK573AX	Triode, High-Freq. Osc.	0.300x0.400	1.5	1.25	200	2000		90.0	11.0			−4.0
CK574AX	Shielded Pentode RF Amplifier	0.290x0.390	1.25	0.625	20	160		22.5	0.125	22.5	0.04	−0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	650	65.0	67.5	3.25	67.5	1.1	−6.5
CK5676/CK556AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	120	1600		135.0	4.0			−5.0
CK5677/CK568AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	60	650		135.0	1.9			−6.0
CK5678/CK569AX	Shielded RF Pentode	0.300x0.400	1.515	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5×10^{-15} amps.	0.285x0.400	1.25	0.625	20	1.5†		12.0	0.22			−3.0
CK5785	High voltage rectifier	0.300x0.400	1.5	1.25	15				0.1	Inverse peak 3500 volts		
→ CK5851	Class C. RF Beam Tetrode	0.400	1.6	1.25	110	1600		125	5.5	125	1.0	−7.5
→ CK5889	7.5 ma. filament electrometer pentode $I_g = 3 \times 10^{-15}$ amps. max.	0.285x0.385	1.6	1.25	7.5	14		12.0	0.005	4.5	0.005	−2.0
VOLTAGE REGULATORS												
CK5783	Voltage reference tube — like 5651	0.400	1.625	Operating voltage 87. Operating current range 1.5 to 3.5 ma.								
CK5787	Voltage regulator	0.400	2.06	Operating voltage 100. Operating current range 5 to 25 ma.								

CK ® RK ®

†Voltage Gain Ratio.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

Excellence in Electronics SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES

TECHNICAL EDITORS AND WRITERS

These are senior positions, the men selected must be able to outline, compile, edit, proofread, plan and check art, dummy, and direct the final publication of technical and scientific publications.

A good working knowledge of radio and radar theory and application is essential, in addition to extensive editorial and journalistic experience. Some knowledge of structural and mechanical engineering is desirable.

Send complete resume with first letter to:

James E. Thompson
Department 29
HUGHES AIRCRAFT COMPANY
Culver City, California

All replies will be handled in the strictest confidence

(Continued from page 52A)

Minimum of 2 years experience UHF desirable. Must be capable of assuming project responsibility. Location Connecticut. Excellent opportunity. Salary high. Submit resume. Box 631.

ELECTRONIC ENGINEERS

Electronic engineers with a background in patent specification writing desired for an expanding Patent Dept. in a growing research and development organization located in the midwest. Unlimited opportunity for advancement for properly qualified men. Law degree unnecessary. Must be U. S. citizen and free to make occasional trips to Washington, D.C. Please give full details in first letter. Box 630.

ELECTRONIC ENGINEERS

The U. S. Naval Ordnance Experimental Unit is located at the National Bureau of Standards, Washington, D.C. The following vacancies exist in grades GS 14, $8,800, GS 13, $7,600 and others of Electronic Engineers (General) (Radar) (Instrumentation) and (Stabilization). Assignments will include consultation, evaluation and product engineering in the development of guided missile components. Enclose copy of Civil Service Application Form 57 (obtainable at local post office) and address completed form to Officer in Charge, U. S. Naval Ordnance Experimental Unit, National Bureau of Standards, Washington 25, D.C.

(Continued on page 56A)

ENGINEERS & DESIGNERS
EQUIPMENT DEVELOPMENT

GENERAL ELECTRIC COMPANY HAS IMMEDIATE OPPORTUNITIES FOR EXPERIENCED EQUIPMENT DEVELOPMENT ENGINEERS AND DESIGNERS

Must have thorough knowledge automatic equipment and manufacturing processes for receiver tubes, television receivers and components.

Men needed must be able to supervise as well as know details of designing and developing automatic machinery.

Write Electronics Dept., General Electric Co., P.O. #1122, Electronics Park, Syracuse, N.Y., giving detailed resume, work record, references, salary requirements and availability.

WRITE FOR JOB IN SAN DIEGO

ELECTRONICS ENGINEERS

We need engineers for electronics research development and production. Real opportunity for graduate engineers with 5 or more years experience in basic circuit design, pulse, micro-wave, system analysis, electronic project coordination and administration. Openings for project leaders, senior designers, assistant project leaders and staff specialists.

Congenial associates, and superior living conditions in wonderful San Diego. *Write today* to H. T. Brooks, Engineering Personnel Office,

NOW

CONVAIR

(Consolidated Vultee Aircraft Corporation)
3302 PACIFIC HIWAY, SAN DIEGO, CALIFORNIA

PHYSICISTS AND ENGINEERS

You can find plenty of positions where you will work on minor improvements on radar, telemetering systems, and other conventional devices. However, you will find very few positions where you can break ground in new fields having tremendous significance. This you can do at the JACOBS INSTRUMENT COMPANY, whose entire effort is devoted to pioneering activities in new fields that it has opened up itself. One of these fields, for example, is that of ultra-high speed, ultra-compact digital computers and controllers. This company's JAINCOMP family of computers dominates this field. Other equally important fields are being developed. Engineers and physicists with sound backgrounds and experience in the design of advanced electronic circuits or precision mechanical instruments may qualify, also individuals with good backgrounds in applied physics. A few openings exist for outstanding junior E. E.'s and physicists, also experienced technicians; applicants for these positions must apply in person.

JACOBS
INSTRUMENT CO.
4718 Bethesda Ave.
Bethesda 14, Maryland

..this letter speaks for itself!

Admiral Corporation
SERVICE DIVISION
201 E. NORTH WATER STREET • CHICAGO 11 • TELEPHONE HOWARD 4-4622

Mr. Mal Bushring
Simpson Electric Company
5200 West Kinzie Street
Chicago 44, Illinois

Dear Mal:

This is to tell you how delighted we are here at Admiral with the new Model 303 Simpson Vacuum Tube Volt-Ohmmeter. It certainly is a versatile instrument for television servicing.

The large meter is very legible, and yet the instrument itself is a compact size. I particularly like the AC voltage range, which is the widest I've ever seen on this type of instrument.

Our service engineers think you've done a good job on the Operator's Manual, too, because it is both complete and concise.

Of course, we've used the Simpson Model 260 Volt-Ohm-Milliammeter for years. The "303" is a fine companion instrument to the "260".

Congratulations!

Sincerely yours,

M J Schinke

ADMIRAL CORPORATION
M. J. Schinke
National Service Manager

MJS:ar

WORLD'S LARGEST MANUFACTURERS OF RADIO PHONOGRAPHS WITH AUTOMATIC RECO
AM-FM Radios • Television • Radio-Phonographs • Refrigerators • Home Freezers

Model 303
VACUUM TUBE VOLT-OHMMETER

SPECIFICATIONS

DC Voltage
Ranges 1.2, 12, 60, 300, 1200 (30,000 with Accessory High Voltage Probe)
Input Resistance 10 megohms for all ranges
DC Probe with one megohm isolating resistor Polarity reversing switch

Ohms *Ranges 1000 (10 ohms center)*
100,000 (1000 ohms center)
1 megohm (10,000 ohms center)
10 megohms (100,000 ohms center)
1000 megohms (10 megohms center)

AC Voltage
Ranges 1.2, 12, 60, 300, 1200
Impedance (with cable) approx. 200 mmf shunted by 275,000 ohms

AF Voltage
Ranges 1.2, 12, 60
Frequency Response Flat to 100,000 cycles

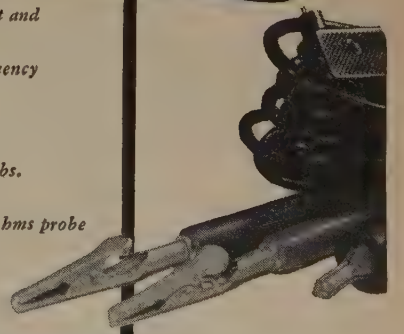
Decibels
Ranges −20 to +3, −10 to +23, +4 to +37, +18 to +51, +30 to +63
Zero Power Level 1 M. W., 600 ohms

Galvanometer
Zero center for FM discriminator alignment and other galvanometer applications

R. F. Voltage
(Signal tracing with Accessory High Frequency Crystal Probe)
Range 20 volts maximum
Frequency Flat 20 KC to 100 M.C.
105-125 V. 60 cycles

Size
5¼"x7"x3⅛" (bakelite case). Weight: 4 lbs. Shipping Wt.: 6½ lbs.

Dealer's Net Price
Model 303, including DCV Probe, ACV–Ohms probe and Ground Lead–$58.75;
Accessory High Frequency Probe, $7.50;
Accessory High Voltage Probe, $14.85
Also available with roll top case, Model 303RT–$64.75



Simpson ELECTRIC COMPANY

5200 WEST KINZIE STREET, CHICAGO 44, ILLINOIS • IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO
Phone: COlumbus 1-1221

ELECTRONIC
INSTRUMENTATION
ENGINEERS

Manufacturer of meteorological instruments requires

PROJECT ENGINEERS

Experience in computer circuits, marker generators, display networks and pulse modulator design mainly for airborne equipment. Design experience with sub-miniature components is desirable

PROJECT ENGINEERS

Several years experience in microwave techniques in the 1 centimeter region, capable of designing antennas, direction couplings, mixers, etc.

ENGINEERS

Experience in the design of transformers, coils, etc., for electronics equipment.

Send complete resume to:

Personnel Department
FRIEZ INSTRUMENT DIVISION
BENDIX AVIATION
CORPORATION
Taylor Avenue at Loch Raven Blvd.
Baltimore 4, Md.

TRANSMISSION-
EQUIPMENT-
DESIGN-
ENGINEERS

West Coast manufacturer of carrier equipment plans expansion program in United States and Canada. Wishes to contact a small number of experienced telephone and telegraph engineers interested in permanent positions offering excellent futures in a well-established but expanding industry.

Several positions will become available during the next year. Salaries commensurate with training and experience will be arranged for men selected. Please give full details in first reply.

Lenkurt

Lenkurt Electric Co.
1105 County Rd., San Carlos, Calif.
926 East Hastings St., Vancouver, B.C.

Positions Open

(Continued from page 54A)

ELECTRONIC ENGINEER

Electronic engineer with interest in instrumentation and automatic control to join instrument development group at the Wind Tunnels Laboratory. Starting salary $3,100-$3,825 per annum. Apply Civilian Personnel Division, Aberdeen Proving Ground, Maryland.

PROFESSORS

Vacancies exist in the Electrical Engineering Dept. for faculty members to teach in undergraduate and post-graduate programs. Starting salaries from $5,400 to $7,600 depending upon experience and educational background. Write to U. S. Air Force Institute of Technology, Dept. of Electrical Engineering, Wright-Patterson Air Force Base, Dayton, Ohio.

★ ★ ★ ★

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

COMMUNICATIONS ENGINEER

B.S.E.E. University of Michigan, February 1950. Age 25, married, 2 children. 3 years Navy Aircraft radio operator and maintenance. Desires communications, electronics, or sales work anywhere in U. S. Box 459 W.

STATISTICAL QUALITY CONTROL ENGINEER

B.S.E.E. MIT, plus statistical quality control, mathematics, statistics, methods, accounting and time study at Columbia. Experience: 4 years industrial field coordination engineer; 4 years inspection administration, Lt. Commander. Desires position as liaison with production, inspection, engineering and sales for quality control div. Member ASQC. Box 460W.

ENGINEER

M.S.E.E., MIT, Tau Beta Pi, Sigma Xi. Age 29. 2 years experience in radar while in service. 3 years experience in microwave measurements and development. Desires electrical engineering teaching position in midwest. Box 461 W.

(Continued on page 58A)

Positions available for

SENIOR
ELECTRONIC
ENGINEERS

with

Development & Design Experience

in

MICROWAVE RECEIVERS
PULSED CIRCUITS
SONAR EQUIPMENTS
MICROWAVE
COMMUNICATIONS
SYSTEMS

Opportunity For Advancement Limited only by Individual Ability

Send complete Resume to:
Personnel Department

MELPAR, INC.
452 Swann Ave.
Alexandria, Virginia

PHYSICISTS
AND
SENIOR RESEARCH
ENGINEERS

POSITIONS NOW OPEN

Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

- Microwave Techniques
- Moving Target Indication
- Servomechanisms
- Applied Physics
- Gyroscopic Equipment
- Optical Equipment
- Computers
- Pulse Techniques
- Radar
- Fire Control
- Circuit Analysis
- Autopilot Design
- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

NORTH AMERICAN AVIATION, INC.
Aerophysics Laboratory
Box No. N-4, 12214 South Lakewood Blvd.
Downey, California

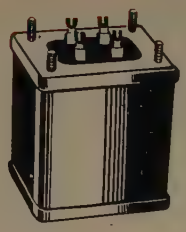
FREED

TRANSFORMERS & INSTRUMENTS

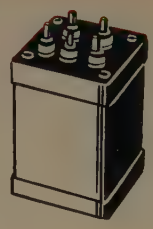
"PRODUCTS OF EXTENSIVE RESEARCH

NO. 1060 VACUUM TUBE VOLTMETER INPUT IMPEDANCE 50 MEGOHMS

NO. 1030 LOW FREQUENCY "Q" INDICATOR



HIGH FIDELITY TRANSFORMERS ½ DB 20 CPS TO 30 KC



DISCRIMINATORS 10 CPS TO 1 MC

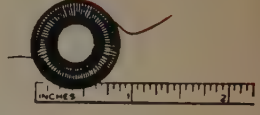
COMMERCIAL COMPONENTS QUALITY — DEPENDABILITY — PRICE

NO. 1140 NULL DETECTOR COMPLETE WITH SELECTIVE CIRCUITS

NO. 1020 MEGOHMMETER 2,000,000 MEGOHMS DIRECT READING

HERMETICALLY SEALED COMPONENTS TO MEET MIL-T-27 SPECS.

TOROIDAL INDUCTORS 60 CPS TO 1 MC



MINIATURE INDUCTORS 1000 CPS TO 100 KC

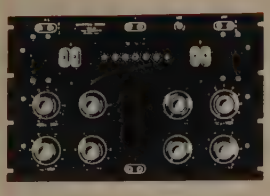
NO. 1210 NULL DETECTOR & VACUUM TUBE VOLTMETER

DECADE INDUCTORS 30 CPS TO 300 KC

SUB MINIATURE HERMETICALLY SEALED TOROIDAL INDUCTORS

SUB MINIATURE HERMETICALLY SEALED COMMUNICATION COMPONENTS

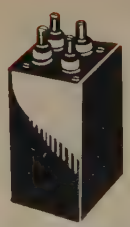
SLUG TUNED COMPONENTS 1000 CPS TO 1 MC



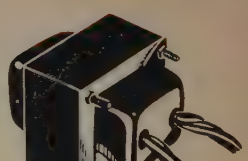
NO 1150 UNIVERSAL BRIDGE 5 A.C BRIDGES IN ONE UNIT

NO 1010 COMPARISON BRIDGE FAST, ACCURATE, RELIABLE

STEPDOWN TRANSFORMERS 50 WATTS TO 3 KW



PULSE TRANSFORMERS FROM WATTS TO MEGAWATTS



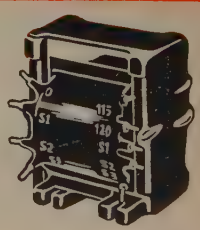
POWER TRANSFORMERS RUGGED, DEPENDABLE, INEXPENSIVE,

1170 D.C. SUPPLY DIRECT CURRENT UP TO 500 MA.

NO. 1110 INCREMENTAL INDUCTANCE BRIDGE A NECESSITY FOR EVERY LAB.

PRECISION FILTERS 10 CPS. TO 1 MC.

CHANNEL MOUNTING INEXPENSIVE—RELIABLE



FOSTERITE TREATMENT ANE-19 SPECS.

SEND FOR LATEST CATALOG!

FREED TRANSFORMER CO., INC.

DEPT. NP 1718-36 WEIRFIELD ST., (RIDGEWOOD) BROOKLYN 27, NEW YORK

NATIONAL UNION RESEARCH DIVISION

Electrical Engineers and Physicists are needed for research on Cathode Ray, Subminiature, Secondary Emission and other types of Vacuum Tubes.

Permanent interesting positions are available in the following fields:

Tube design & development
Tube processing
High vacuum systems
Solid state physics
Electron optics
Phosphorescence

Men qualified in any of the above are invited to send their resumes to:

Divisional Personnel Manager
National Union Research Division
350 Scotland Rd., Orange, N.J.

RCA VICTOR Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 960, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

Positions Wanted

(Continued from page 56A)

SALES OR APPLICATION ENGINEER (JR.)

B.E.E. June 1950, Pratt Institute; age 24; married. Former AETM 3/c, radio and radar service in U.S. Navy. Interested in sales or application. Hard, willing worker. Any location in U. S. or Alaska. Resume. Box 462 W.

ELECTRONIC ENGINEER

B.E.E. June 1950, upper fifth, Syracuse University. Married, 1 child. Experience in radio, radar and antenna research. Interested in television, electronics, radio communication. Location anywhere in U. S. Box 467 W.

JUNIOR ENGINEER OR LABORATORY TECHNICIAN

Specialty precision instruments. 5 years experience on development of photo-electric instruments, electrocardiographs, timers, pulse transmitters and control systems. 3 years engineering college at Pratt Institute and New York University. Desires position in design or development work. Box 468 W.

COMUNICATIONS ENGINEER

7 years experience in communications and VHF control systems in CAA and Army 2 years at supervisory level. Graduate C.R.E.I. Married. Age 26. Interested in VHF-UHF design or development. Location immaterial. Available Sept. 15. Box 469 W.

ENGINEER

B.A. New York University, physics and psychology majors; graduate RCA Institute; age 33; 6 years broadcast engineering, 4 years teaching physics, both with administrative responsibilities. Seeks position in engineering administration, New York City location to permit continuing graduate study. Available Oct. 1. Box 470 W.

ELECTRONICS ENGINEER

B.S. Applied Physics. Graduated U.C.L.A. August 1950. 3 years as Army electronic technician. Desires position in industrial electronics with good future. Prefer west coast. Married. Age 26. Box 471 W.

ELECTRICAL ENGINEER

B.S.E.E. June 1950, Polytechnic Institute of Brooklyn. Age 26, single. F.C.C. radio phone license. 3 years electronic experience including design, construction and testing; 6 months radio repairman in Air Corps. Interested in sales, service, development or broadcast engineering. Resume on request. Box 472 W.

JUNIOR ELECTRONIC ENGINEER ENGINEER

B.S.E.E. June, 1950, New York University. Age 23, single. 14 months Army. Attended Signal Corps school. 5 years radio and some television set repair part time. Desires communication or electronic work anywhere in U.S. Box 473 W.

ENGINEER

B.E.E.; M.E.E. August 1950, Syracuse University. Age 23, single. Communications major. 1 year Navy electronics technician, 1 year laboratory instructor. Tau Beta Pi, Pi Mu Epsilon, Sigma Pi Sigma. Desires communications work. Salary and location secondary. Box 474 W.

(Continued on page 62A)

PROJECT ENGINEERS

Opportunities exist for graduate engineers with design and development experience in any of the following:

ANALOGUE COMPUTERS
SERVO MECHANISMS
RADAR
ELECTRONIC CIRCUITS
COMMUNICATION EQUIPMENT
AIRCRAFT CONTROLS
HYDRAULICS
INSTRUMENTATION
ELECTRONIC PACKAGING
PRINTED CIRCUITS
PULSE TRANSFORMERS
FRACTIONAL H. P. MOTORS

Submit Resume to Employment Dept.

SPERRY GYROSCOPE CO.
Division of the Sperry Corp.
GREAT NECK, L.I., NEW YORK

ENGINEERING OPPORTUNITIES IN Westinghouse

Wanted:

Design Engineers
Field Engineers
Technical Writers

Must have at least one year's experience.

For work on airborne radar, shipborne radar, radio communications equip., microwave relay, or micro-wave communications.

Good pay, excellent working conditions; advancement on individual merit; location Baltimore.

Send resume of experience and education to: Manager of Industrial Relations, Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Maryland.

specify Sorensen AC VOLTAGE REGULATORS

Accuracy, with rugged construction, economical and trouble-free operation, reasonable cost — those are features that you expect, *and get*, when you specify Sorensen regulators!

ALL SORENSEN REGULATORS HAVE THESE ADVANTAGES:

- Wide Input Range
- Adjustable Output Voltage That Stays Set
- Regulation Accuracy of ± 0.1%
- Excellent Waveform
- Fast Recovery Time
- Insensitivity to Line Frequency Fluctuations.

MODEL NO. 500-S

STANDARD AC SPECIFICATIONS

VA capacity	150 500	250 1000	2000 3000	5000 10000 15000
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
Regulation accuracy	± 0.1% against line or load			
Input voltage	95-130 VAC; also available for 190-260 VAC single phase 50-60 cycles			
Output voltage	Adjustable between 110-120; 220-240 in 230 VAC models			
Load range	0 to full load			
P.F. range	Down to 0.7 P.F. All models temperature compensated			

NOTE: THREE PHASE AND 400 CYCLE REGULATORS ALSO AVAILABLE. ALL REGULATORS CAN BE HERMETICALLY SEALED.

Write for Complete Literature

For regulated DC problems investigate Sorensen's line of Voltage Reference Standards, DC Supplys, and NOBATRONS

POWER controlled converted

Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTERS; VOLTAGE REFERENCE STANDARDS; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

One OF A LINE....

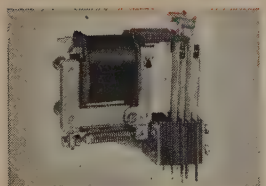
SERIES 405 D.C.

No better proving place for Guardian Hermetically Sealed Relays than Uncle Sam's battlewagons that ride the oceans everywhere.

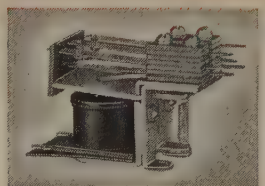
The GUARDIAN SERIES 405 D.C. RELAY

For example: the Guardian Series 405 Telephone Type Relay, used for communications, is an "all-purpose" type especially suited to sensitive applications. Instantly responsive. Operates at high speed. Provides a time delay on attract or release when equipped with a copper slug on the coil. Armature hinges on pin-type bearing to insure (1) long wear, (2) freedom from binding and (3) minimum side play. Standard weight of hermetically sealed Series 405 (DPDT) Relay: 11.5 oz. Also available with special windings.

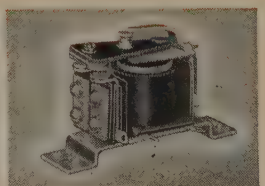
New Hermetically Sealed Relay catalog 5-H is yours for the asking.



Series 30 A.C.

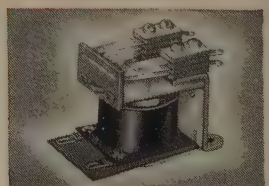


Series 210 A.C.—215 D.C.



Series 220 A.C.

Series 695 D.C.



Series 610 A.C.—615 D.C.

Write— ASK US TO MAKE SPECIFIC RECOMMENDATIONS. NO OBLIGATION.

GUARDIAN ELECTRIC

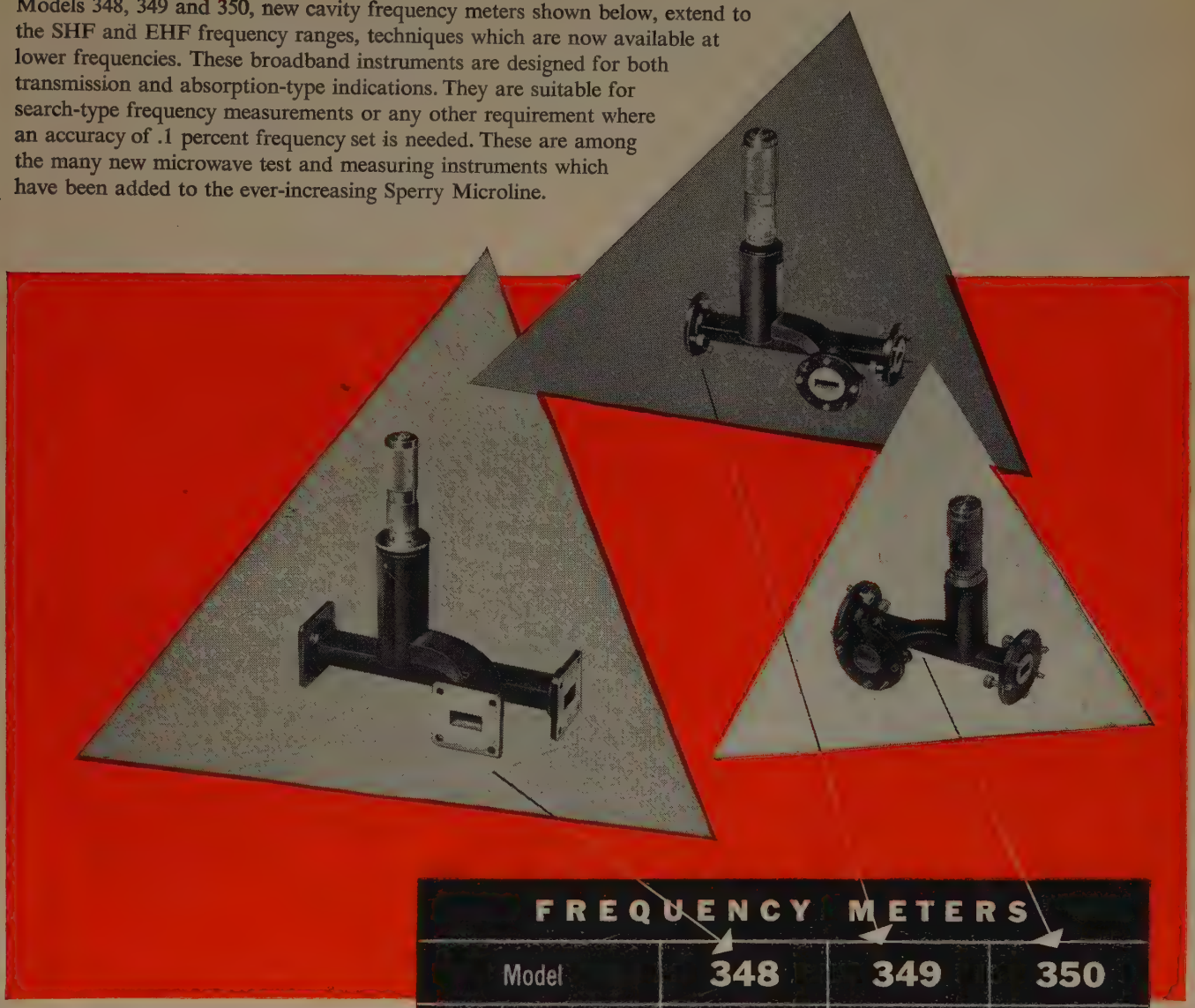
1628-M W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

New Instruments for Microwave Testing

COMPLEMENT SPERRY'S *Microline*®

Models 348, 349 and 350, new cavity frequency meters shown below, extend to the SHF and EHF frequency ranges, techniques which are now available at lower frequencies. These broadband instruments are designed for both transmission and absorption-type indications. They are suitable for search-type frequency measurements or any other requirement where an accuracy of .1 percent frequency set is needed. These are among the many new microwave test and measuring instruments which have been added to the ever-increasing Sperry Microline.



FREQUENCY METERS			
Model	348	349	350
Description	CAVITY	CAVITY	CAVITY
Frequency Range mc	13,000-18,000	19,000-26,000	26,500-39,000
Absolute Accuracy	1/1000	1/1000	1/1000
Approximate Loaded Q	1000	450	1000
Fittings R-F	UG-419/U	UG-425/U	UG-381/U
Fittings Video	UG-419/U	UHF	UG-381/U

Other new instruments in the frequency ranges of the above mentioned meters are:

Instrument	Model	Frequency Range mc
Impedance Meter	320	18,000-26,500
Impedance Meter	346	26,500-40,000
Impedance Transformer	347	26,500-40,000
Directional Coupler	405	26,500-39,000
Directional Coupler	413	18,000-26,500
Directional Coupler	415	18,000-26,500
Directional Coupler	388	12,400-17,000
Directional Coupler	429	32,000-39,000
Short	371	26,500-40,000
Short	372	12,400-18,000
Termination	401	12,400-18,000
Termination	402	26,500-40,000
Detector and Mixer	357	12,400-18,000
Detector and Mixer	358	18,000-26,500
Detector and Mixer	359	26,500-40,000
Detector and Mixer	382	26,500-40,000
Magic Tee	390	18,000-26,500
Magic Tee	391	26,500-40,000

Catalog information on these and other Microline instruments is available on request.

*Trade Mark

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION, GREAT NECK, NEW YORK • CLEVELAND • NEW ORLEANS • NEW YORK • LOS ANGELES • SAN FRANCISCO • SEATTLE

EXPERIENCED DEVELOPMENT ENGINEER

CAREER

for

Qualified individual with company whose reputation for leadership and progress is recognized throughout the world.

Laboratory assignment involving creative application of the physical sciences to precision electromechanical devices.

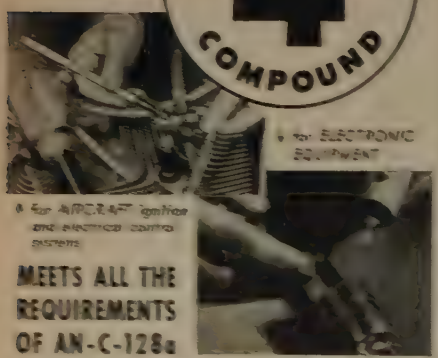
Location: South Central N.Y. State.

Give full details of education and experience, indicating age and marital status.

Box No. 635
The Institute of Radio Engineers
1 East 79th St. New York 21, N.Y.

The nonmelting SILICONE insulating and waterproofing compound that is stable at temperatures from -70°F. to +400°F.

DOW CORNING 4 COMPOUND



for ELECTRONIC EQUIPMENT

for AIRCRAFT ignition and electrical control systems

MEETS ALL THE REQUIREMENTS OF AN-C-128a

More water repellent than paraffin, Dow Corning 4 Compound is highly resistant to ozone, arcing and its deterioration caused by corona discharge.

POWER FACTOR, up to 10 megacycles ... 0.001
VOLUME RESISTIVITY, ohm centimeters ... 10^
DIELECTRIC STRENGTH, volts/mil ... 500

Write Today!

Dow Corning
FIRST in SILICONES

DOW CORNING CORPORATION, Midland, Michigan

Positions Wanted

(Continued from page 58A)

TELEVISION ELECTRONICS TECHNICIAN

2½ years B.E.E. New York University. 2 years Naval Electronics Radar Technician. 2 years TV experience in production test and field engineering for New York manufacturer. Desires position New York-Long Island area. Resume on request. Box 489 W.

ENGINEER

B.E.E. electronics option, University of Minnesota, June 1949, high scholastic standing. 3 years Army Signal Corps radio repairing and operating. Desires electronic design or development position. Location immaterial. Box 490 W.

ENGINEER

Age 43, married. Extensive practical radio, FM, TV and communications experience. Desires position as Service Manager with a reputable distributor. New York, New Jersey or Conn. area. Resume on request. Box 491 W.

SUBMINIATURIZATION ENGINEER

Graduate, M.A. qualified Project Engineer. Heavy experience in subminiaturization techniques. Seeks responsible position with opportunity for doing original work. Box 492 W.

JUNIOR ENGINEER

B.E.E. June 1950, New York University. Desires position in electronics or communications field. Experience remote control repairman on AA guns. 1½ years television and radio repairman. Age 27, single. Willing to relocate anywhere in U.S. Box 493 W.

(Continued on page 65A)

An invitation from Lockheed in California to

SENIOR ELECTRONIC SYSTEMS ENGINEERS

Lockheed invites you to participate in its long-range production program, developing the aircraft of the future.

Lockheed offers an attractive salary commensurate with your ability and background, a future in aeronautical science. In addition, Lockheed provides generous travel allowances for those who qualify.

If you have:

1. An M.S. or Ph.D. in Electrical Engineering or Physics—
2. A minimum of three years' experience in advanced electronic systems development, including radar microwave techniques, servomechanisms, computers and fire control—
3. Familiarity with airborne electronics equipment requirements—

Write today—giving full details as to education, experience and salary requirements. Address:

Karl R. Nunn, *Employment Manager*
LOCKHEED Aircraft Corporation
Burbank, California

RADAR AND SONAR ENGINEERS

Supervisory Radar Engineer

1. Position open for top-notch radar engineer to supervise project engineers in the development and production engineering of airborne radar equipment.

Radar Engineers

2. Positions open for project, senior and junior radar engineers. Experience in airborne radar desired.

Sonar Engineers

3. Positions open for engineers with background and experience in the field of sonar.

Salary commensurate with ability and experience. Excellent opportunity for suitably qualified personnel.

Submit detailed resumé.

Attention
CHIEF ELECTRONIC ENGINEER

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

ANALOGUE COMPUTER ENGINEER

Experienced graduate electrical engineer with extensive background in analogue computer development, required to supervise analogue computer section. This engineer must be able to assume full technical responsibility and planning for projects ranging from single equipments to complete system development. Here is a life time opportunity for the individual who can organize a rapidly expanding facility. Submit detailed resume. Personal interview will be arranged.

ENGINEERING RESEARCH ASSOCIATES, INC.
1902 West Minnehaha Avenue
St. Paul 4, Minnesota

Advanced aerodynamic design is what you expect when a top team of designers like those of the Fairchild Guided Missiles Division build a missile. But that is only part of the problem in missile manufacture.

A guided missile is packed from nose to tail with complex electronic guidance circuits that must control its flight accurately—even during the shock of launching and the high G loads of tight turns. The *avionic brain* must not "black out" even under loads well beyond those a human pilot can withstand.

In Fairchild's missiles, not only the airframe but the complete missile, including the *avionic brains* —that are squeezed into the cramped quarters of the missile's body—are Fairchild designed and Fairchild manufactured.

To prove the ruggedness and reliability each missile is subjected to G loads never before asked of electronic equipment, while test apparatus shows how the "bird" stays locked on the target. Flight tests confirm this amazing accuracy and ruggedness.

Here is another example of Fairchild research and development at work for the Armed Services.

Far ahead in the field. Fairchild Guided Missiles are an example of the achievement possible when top-flight aerodynamicists and ingenious electronic engineers tackle closely interrelated problems as a single, united team.

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD *Guided Missiles Division*

FARMINGDALE, N. Y.

Other Divisions: Fairchild-NEPA Division, Oak Ridge, Tenn. • Fairchild Aircraft Division, Hagerstown, Md.
Fairchild Engine Division, Al-Fin Division and Stratos Corporation, Farmingdale, N. Y.

You can use a battering ram to make it fit...

BUT it's simpler to design the radio around the battery!

Regardless of what size portable radio you are designing, you'll find compact, long-lasting "Eveready" batteries to fit it. "Eveready" brand batteries give longer playing life. They are the accepted standard for portable radios. Users can get replacements everywhere — they *prefer* portables that use "Eveready" batteries.

CONSULT OUR BATTERY ENGINEERING DEPARTMENT FOR COMPLETE DATA ON "EVEREADY" BATTERIES

● The No. 753 "Eveready" "A-B" battery pack provides plenty of power for compact "pickup" portables. For smaller portables, we recommend "Eveready" No. 950 "A" batteries and the No. 467 "B" battery.

"Eveready", "Mini-Max", "Nine Lives" and the Cat Symbol are trade-marks of

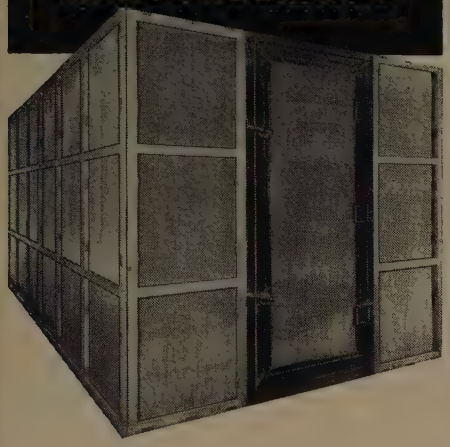
NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N.Y.

EVEREADY
TRADE-MARK
RADIO BATTERIES

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

TESTED
Laboratory
TESTED

SCREEN ROOMS
for ACCURATE
RADIO-FREQUENCY
MEASUREMENTS



Guesswork is eliminated when you use an ACE Pre-built Screen Room. The area background level of radio interference is suppressed and the room does not introduce any errors in your measurements. Attenuations of 100 db.—and higher—at frequencies as low as 0.15 and as high as 10,000 mc. are readily obtainable. Specially designed Screen Rooms can give attenuations as high as 140 db.

ACE attenuation characteristics have been determined by reputable electronic laboratories. These Screen Rooms are used for various applications such as evaluation and suppression of radio interference; radio and radar calibration, sensitivity,susceptibility, spurious response and radiation; measurements involving electronic instruments used in medical laboratories and many others. Write for descriptive bulletin.

Easily installed
Easy to move or to enlarge
Low priced

ACE

ACE ENGINEERING and MACHINE CO., INC.
3644 N. Lawrence Street
Philadelphia 40, Pa. Regent 9-1019

Positions Wanted

(Continued from page 62A)

SALES ENGINEER

B.E.E. June 1947, Polytechnic Institute of Brooklyn, Eta Kappa Nu. 2 years varied radar, radio, electronic technical experience. 1 year own business. Single, age 25. Box 494 W.

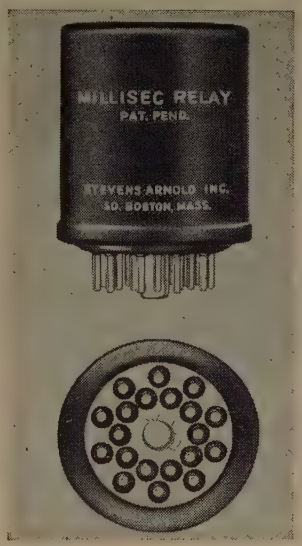
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 48A)

Ultra-High-Speed DC Relay

The Millisec Relay, designed for long life reliable ultra-high-speed use at an operating time of one millisecond or less, is being marketed by **Stevens-Arnold Inc.**, 22 Elkins St., South Boston 23, Mass. It is assembled in a standard metal radio tube container, but its operation is mechanical and not electronic.



Only direct current should be applied to the contacts. In contrast to conventional relays, the manufacturer does not recommend the use of ac.

Life increases from 22 million operations at $\frac{1}{2}$ ampere on the contacts to 100 million operations at $\frac{1}{4}$ ampere, at a rate of 60 operations per second. Below $\frac{1}{4}$ ampere a further increase in life can be expected.

The relay is designed for operation with a resistive load, and when so connected, does not require an external spark suppression circuit. When used with an inductive load, the actual load used must be sent to our factory for the special tests required in order for us to design and specify the circuit constants of the spark suppression circuit always needed when operating with an inductive load.

The maximum rating is $\frac{1}{2}$ ampere 110 volts dc on the contacts into a resistive load. Some overloading is possible above $\frac{1}{2}$ ampere, but the life expectancy is greatly reduced.

Each relay is enclosed in a standard 6N7 type metal radio tube container, and wax sealed in order to prevent dust and moisture from reaching the contacts.

(Continued on page 66A)

Acme Electric has been identified with the electronic industry since the crystal set days. The vast store of experience that Acme engineers have accumulated over these many years can be of considerable value in helping you solve your electronic transformer problems. We offer transformer engineering cooperation and facilities to build quality transformers in quantity production.

ACME ELECTRIC CORP.
4411 Water Street Cuba, N.Y., U.S.A.

Acme ACME Electric
TRANSFORMERS

MORE GEO. STEVENS COIL WINDING EQUIPMENT IS IN USE THAN ALL OTHER MAKES COMBINED!

• **MORE OUTPUT . . . LOWER COSTS** . . . from *EXCLUSIVE* SPEED FEATURE. Universal motors permit variable speeds without changing belts and pulleys. Coil design permitting, speeds as high as 7500 RPM are not uncommon.

• **PORTABILITY.** Conveniently carried from place to place. Machines come mounted on bases to constitute one complete unit.

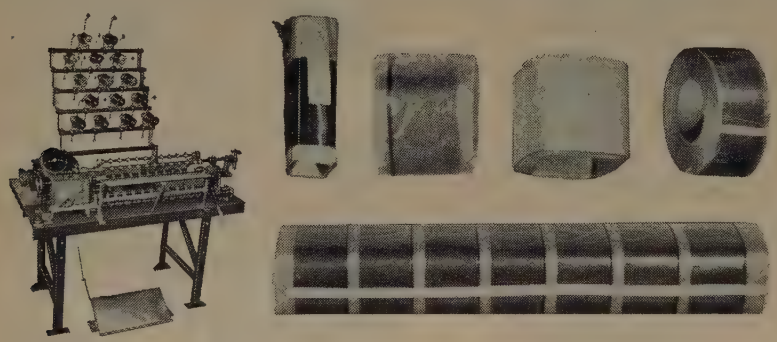
• **MUCH LOWER ORIGINAL COST.** The same investment buys more GEO. STEVENS machines than any other coil winding machines.

• **LONG LIFE.** Most of the original GEO. STEVENS machines bought 14 years ago are still operating daily at full capacity.

• **MUCH FASTER CHANGING OF SET-UPS** than any other general purpose coil winding machine. Quickly changed gears and cams save time between jobs.

• **VERY LOW MAINTENANCE.** Replacement parts are inexpensive, can be replaced in minutes, and are stocked for "same day" shipment, thus saving valuable production time.

• **EASIEST TO OPERATE.** In one hour, any girl can learn to operate a GEO. STEVENS machine.



Transformer winder Model 37S multiple winds power, audio, automotive, fluorescent ballast and similar types of coils. Winds wire from No. 18 B&S to 46 B&S up to 9" O.D. Maximum economy is possible by using mandrels up to 30" long. Thirty or more coils may be wound at one time. All turns are accurately registered by Model 50 or 51 6" full vision clock face Dial Counter. Set-ups can be changed in less than 5 minutes. A gear chart is furnished to quickly determine wire spacing.

No loss of turns (an exclusive feature) and accurate margins are assured by a screw feed traverse and an electrically controlled clutch. Highly polished wire guide rollers are ball-bearing mounted for free running. Traverse is quickly adjusted from 1/16" to 6".

Paper feed:—A tilting table for pre-cut paper is furnished making paper feed simple and fast, or a new roll paper feed for extra economy is available at a small additional cost.

Motor equipment:—Variable speed, uniform torque ½ H.P. motor with foot treadle control.

Tension equipment:—12 T-1 tensions and spool rack. Tensions will handle 6" spools.

Mounting:—Ground steel channel base ensures rigidity and permanent alignment. Machine is shipped mounted on bench ready for use.

There is a GEO. STEVENS machine for every coil winding need. Machines that wind ANY kind of coil are available for laboratory or production line. . . . Send in a sample of your coil or a print to determine which model best fits your needs. Special designs can be made for special applications. Write for further information today.

World's Largest Manufacturer of Coil Winding Machines

REPRESENTATIVES

Frank Tatro
6022 No. Rogers Ave., Chicago 30, Illinois
Ralph K. Reid
1911 W. 9th St., Los Angeles 6, California
R. F. Staff & Co.
1213 W. 3rd St., Cleveland 13, Ohio

GEO. STEVENS MFG. CO., INC.
Pulaski Road at Peterson
Chicago 30, Illinois

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 65A)

Voltage-Regulated Power Supply

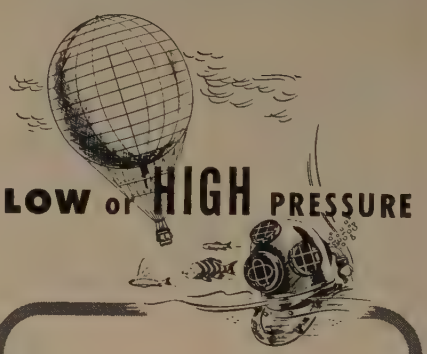
The Model 515 supply which features one regulated B supply, one regulated C supply, and one unregulated filament supply, is being marketed by **Kepco Laboratories, Inc.**, 149-14 41st Ave., Flushing, L. I., N. Y.

The B supply is continuously variable from 0 to 500 volts and delivers from 0 to 200 ma. In the range from 20 to 500 volts the output voltage variation is less than ½ per cent for both line fluctuations from 105 to 125 volts and load variations from minimum to maximum current. Ripple is less than 5 mv.

The C supply is continuously variable from 0 to 150 volts and delivers 5 ma. For all output voltages, the output voltage variation is less than 10 mv for line fluctuations of 105 to 125 volts. At 150 volts, the regulation is less than ½ per cent, between 0 and 5 ma. At other settings below 150 volts the internal resistance of the supply will increase to a maximum of 25,000 ohms. Ripple is less than 5 mv.

The ac output is 6.3 volts, 10 amperes, center-tapped, unregulated.

(Continued on page 68A)

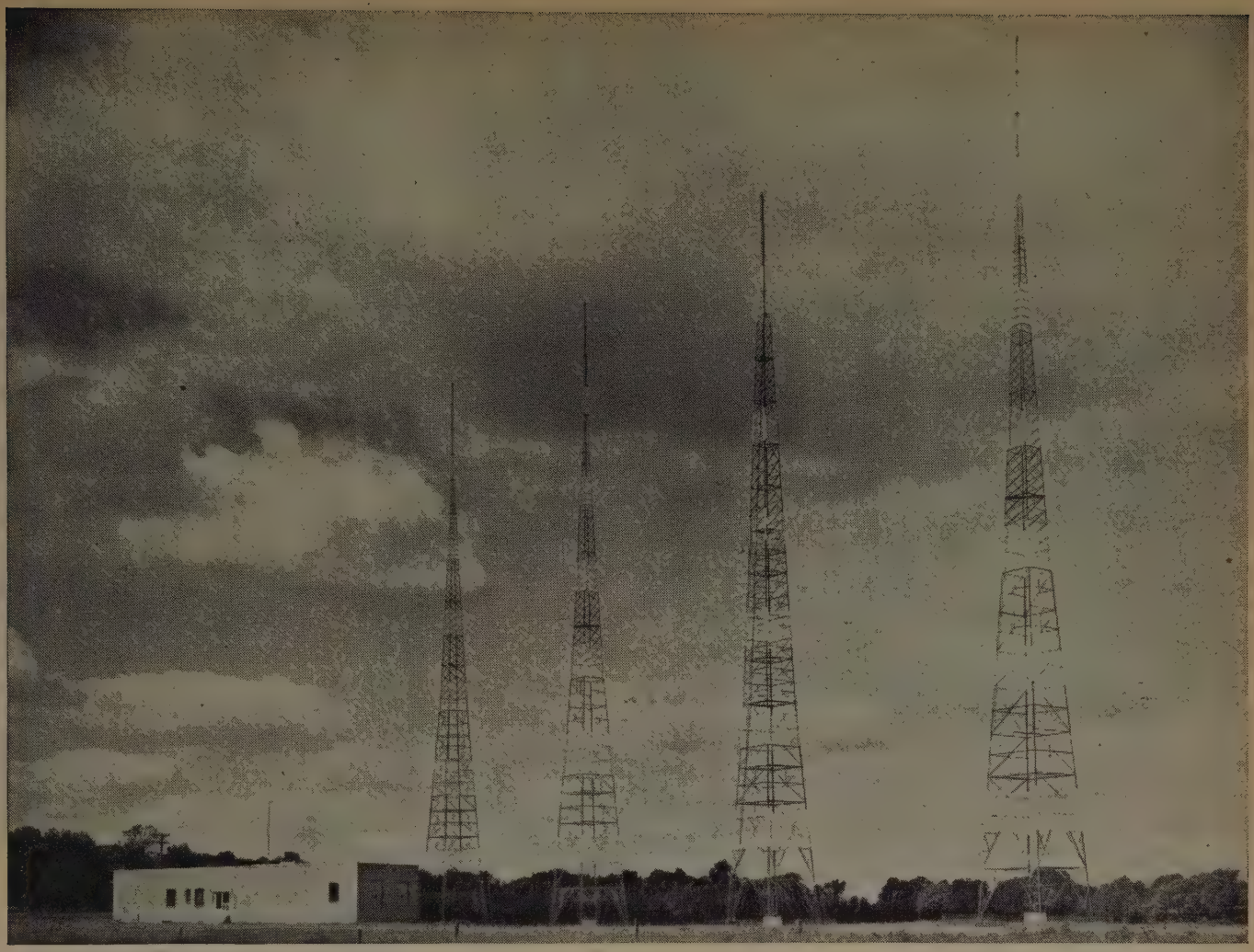


High pressure or low, there is a Giannini precision pressure transmitter that meets your requirements for remote indication, recording or control.

From less than 1 up to 10,000 psi, with various types of resistance and inductive output values, Giannini precision pressure transmitters are designed to withstand extremes of acceleration, temperature, vibration, while at the same time retaining their accuracy and their fast response characteristics. "They are standard with the Leaders." Write for booklet.

G. M. Giannini & Co., Inc., Pasadena 1, California

giannini



WERE WAS "THERE"

—when they specified Blaw-Knox Towers for their powerful new AM, FM, TV station!

WERE's technicians couldn't actually *see* Blaw-Knox engineering or point to Blaw-Knox long experience in tower-building, or show off the inherent strength and efficiency of these towers—*but they knew they were all there!* Hence their choice.

. . . A quotation will prove that there's no premium on Blaw-Knox quality.

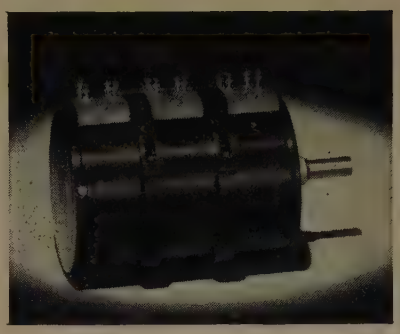
BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2037 Farmers Bank Building, Pittsburgh, Pa.

Distributed by GraybaR
OFFICES IN 100 PRINCIPAL CITIES

BLAW-KNOX ANTENNA TOWERS

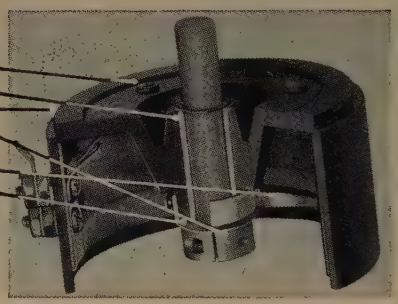
There's a TIC Potentiometer for every application

TIC for top electrical and mechanical precision



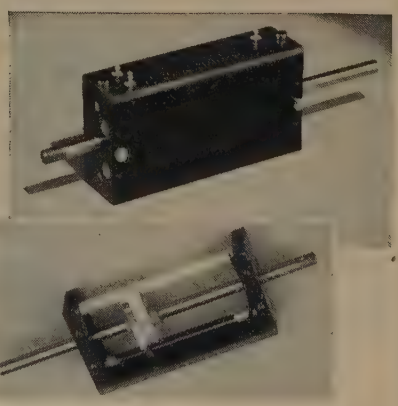
Type RV2 High Precision Potentiometer
One of a series of semi-standardized types of metal-base potentiometers with exceptionally high electrical accuracy and mechanical precision. For both linear and *non-linear* functions. Designed for precision instrument, computer and military applications. Accurate phasing of individual units possible with exclusive clamp-ring method of ganging.

TIC for precision and economy

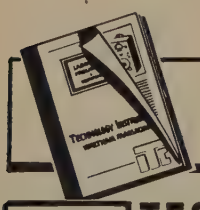

Tapped mounting inserts
Bronze bushing
Totally enclosed with cover
"Constrict-O-Grip" clamping to shaft —(no set screws)
Precious metal contacts
Silver overlay on rotor take-off slip ring

Type RV3 Precision Potentiometers
. . . available in models for either *linear* or *non-linear* functions with stock resistance values ranging from 100Ω to 200,000Ω and power ratings of 8 and 12 watts. 360° mechanical rotation or limited by stops as desired. Models with 5% total resistance accuracy — $6.00 . . . 1% accuracy — $8.00. Special models available for high humidity applications.

TIC for special use . . .



Type RVT Translatory Potentiometer
Actuated by longitudinal instead of rotating motion providing linear electrical output proportional to shaft displacement. Used as a position indicator, high amplitude displacement type pickup and for studying low frequency motion or vibration. Features exceptionally high linearity and resolution. Available in various lengths depending on amplitude being studied.



Valuable catalog — yours for the asking. Contains detailed information on all TIC Instruments, Potentiometers and other equipment. Get your copy without obligation — write today.

TECHNOLOGY INSTRUMENT CORP.

1058 Main Street, Waltham 54, Massachusetts

Representatives and Telephone Numbers

Cleveland, Ohio—PRospect 1-6171 Chicago, Ill.—UPtown 8-1141 Dallas, Tex.—DIxom 9918
Rochester, N.Y.—Genesee 3547-M Cambridge, Mass.—ELiot 4-1751 Canaan, Conn.—Canaan 649
Hollywood, Cal.—HOllywood 9-6305 Boonton, N.J.—BOonton 8-3097 Manhasset, N.Y.—MAnhasset 7-3424 Dayton, Ohio—MIchigan 8721

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 66A)

Traveling-Wave Power Amplifier

The **Federal Telecommunication Laboratories, Inc.,** 500 Washington Ave., Nutley, N. J., has begun production of a traveling-wave power amplifier in the 4,000- to 5,000-Mc frequency range.

This tube has been assigned the type number 5929 and is of the helex type. Particular attention has been given to details which allow ready replacement of tubes and a high degree of interchangeability. The tube will deliver a power output in excess of 10 watts with a power gain of 20 db. The rf terminals are arranged for wave-guide circuit, and the tube operates with an external electromagnet field.

(Continued on page 71A)

ELECTRONICALLY REGULATED

LABORATORY POWER SUPPLIES

• STABLE
• DEPENDABLE
• MODERATELY PRICED
•

MODEL 28
STANDARD RACK MOUNTING
PANEL SIZE 5¼" x 19"
WEIGHT 16 LBS.

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin G8

LAMBDA ELECTRONICS CORPORATION
CORONA NEW YORK

Gold Plated
TUNGSTEN
and
MOLYBDENUM
GRID WIRE

Made to meet your specifications . . . for gold content, diameter and other requirements.

Write for details and list of products

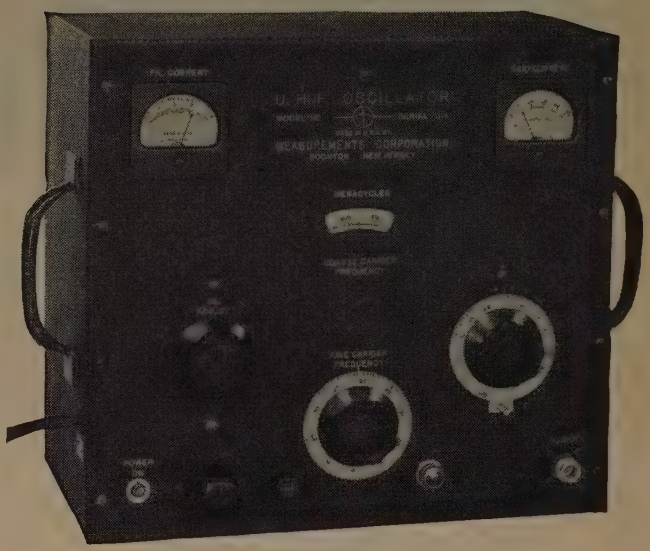
SINCE 1901

SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

UHF OSCILLATOR

FREQUENCY RANGE:

300 Mc. to 1000 Mc.



The MODEL 112 Provides A Signal Source For The Measurement Of—

- STANDING WAVES ON TRANSMISSION LINES
- ANTENNA PATTERNS
- FILTERS
- ATTENUATORS

Also for Alignment and Tracking of UHF Receivers and for many other applications.

MODEL 112

THIS oscillator was designed for the many applications in ultra-high frequency engineering that require a high degree of frequency accuracy and stability. The direct-reading frequency dial is individually calibrated to an accuracy of ±0.5%.

An output dial, calibrated in decibels, permits relative voltage measurements within a ratio of 100 to 1.

FREQUENCY RANGE: 300 to 1000 Megacycles

FREQUENCY CALIBRATION ACCURACY: ± 0.5%

OUTPUT VOLTAGE: Maximum varies with frequency between 0.3 volt and 2 volts. Adjustable over 40 db range

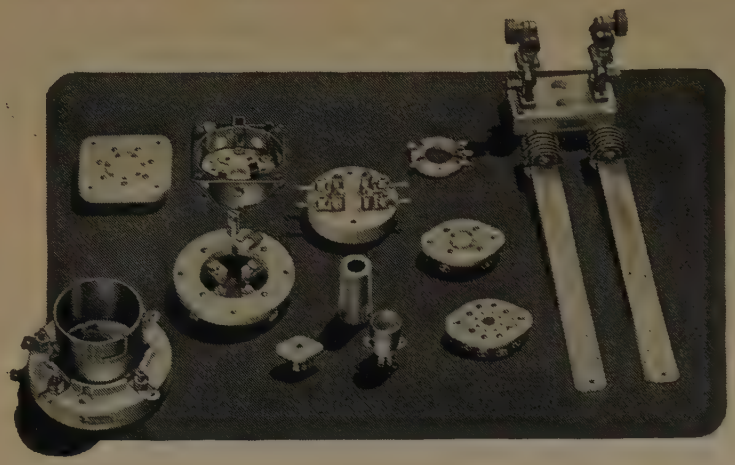
OUTPUT IMPEDANCE: 50 ohms

POWER SUPPLY: 117 volts; 50-60 cycles; 60 watts

DIMENSIONS: 12½" x13½" x 8". Weight 22 lbs.

MEASUREMENTS
CORPORATION
BOONTON NEW JERSEY

STILL TOPS IN THE FIELD



Whatever your power tube application may be, you can, in almost every case, find an ideally suited JOHNSON socket. This socket will have high frequency insulation, low contact resistance and will hold the tube securely. These are characteristics of all JOHNSON sockets.

JOHNSON sockets, furthermore, are easy to use. Design is such that mounting is simple. Insulation and spacing are more than adequate for voltages involved. High frequency tube performance is not impaired by stray capacity.

Write for catalog 971 which describes the most complete line of transmitting and industrial tube sockets on the market.

E. F. JOHNSON COMPANY *. . . a famous name in radio*

WASECA, MINNESOTA

NEW 12 CHANNEL TELEVISION TRANSMITTER

Capable of MUSIC Modulation

PRICED AT A NEW LOW OF $495.00

TYPE 2111

- The ONLY 12 channel TV transmitter that has a sound carrier capable of MUSIC modulation with full 40 KC swing.
- Has standard 75 microsecond pre-emphasis.
- All picture carriers are crystal controlled within 0.01% and modulation of picture carrier is by means of standard RMA Composite Picture Signal.
- Has standard rack mounting panel; power supply fully regulated.
- Just the thing for rapid TV checking on all 12 channels and for checking receivers for tone, speaker rattle and freedom from microphonics.

Write for Type 2111 Data Sheet for Full Details

Manufacturers of a Complete Line of TV Test Equipment

TIC **Tel-Instrument Co. Inc.**

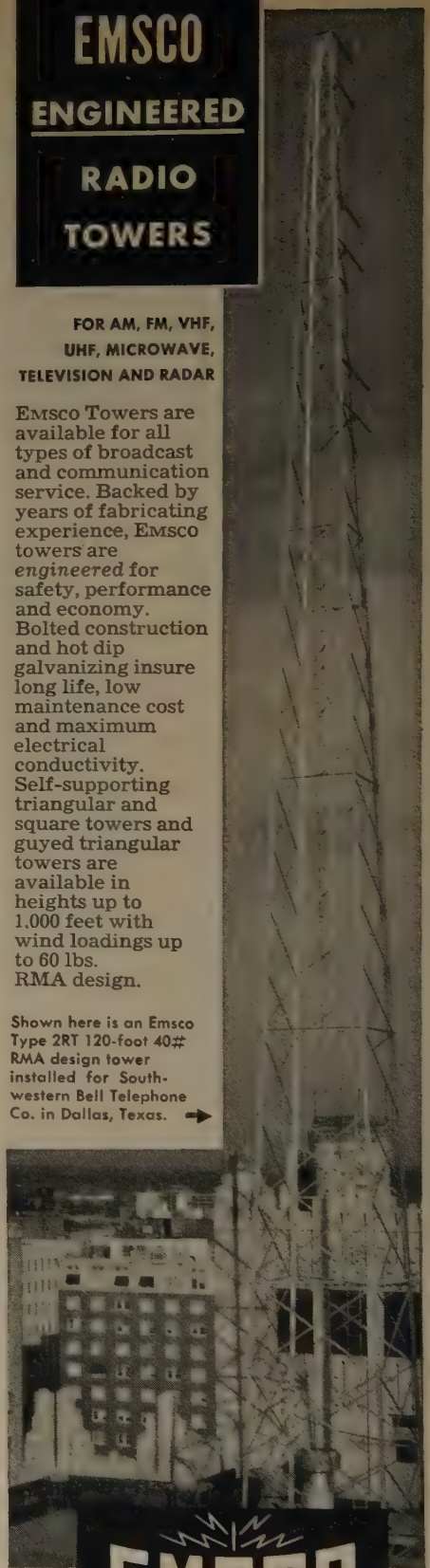
50 PATERSON AVENUE • EAST RUTHERFORD, N. J.

EMSCO ENGINEERED RADIO TOWERS

FOR AM, FM, VHF, UHF, MICROWAVE, TELEVISION AND RADAR

Emsco Towers are available for all types of broadcast and communication service. Backed by years of fabricating experience, Emsco towers are *engineered* for safety, performance and economy. Bolted construction and hot dip galvanizing insure long life, low maintenance cost and maximum electrical conductivity. Self-supporting triangular and square towers and guyed triangular towers are available in heights up to 1,000 feet with wind loadings up to 60 lbs. RMA design.

Shown here is an Emsco Type 2RT 120-foot 40# RMA design tower installed for Southwestern Bell Telephone Co. in Dallas, Texas. ➔



EMSCO

TOWERS OF STRENGTH

EMSCO DERRICK & EQUIPMENT COMPANY

LOS ANGELES, CALIFORNIA

Houston, Texas • Garland, Texas

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation

(Continued from page 68A)

New Deposited Carbon-Type Resistor

The **Bell Telephone Laboratories, Inc.**, 463 West St., New York 14, N. Y., has developed an improved type of deposited carbon resistor which is expected to find wide-spread use in the communications and electronic fields.

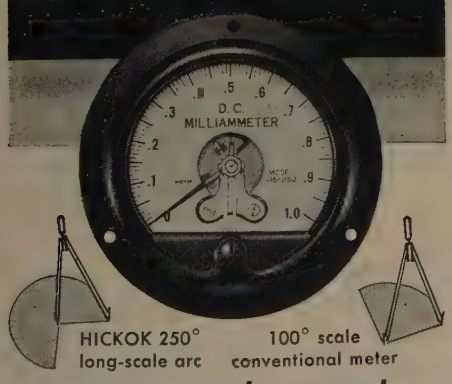
In the new resistor, the element boron, as well as carbon, is pyrolitically deposited in a thin film on a suitable ceramic core. The addition of this element, it has been found, gives considerably lower temperature coefficients of resistance than those possessed by plain carbon resistors, as well as good stability. In addition, the new borocarbon resistors provide access to resistance ranges heretofore impossible to attain in stable, accurate film-type resistors.

Recent years have seen an increasing growth in the use of pyrolytic carbon resistors. Known variously as "cracked carbon resistors" or as "high stability carbon film resistors," they are composed of very thin films of microcrystalline carbon formed over the surfaces of ceramic cores.

(Continued on page 72A)

HICKOK

LONG SCALE METERS



HICKOK 250° long-scale arc 100° scale conventional meter

Easier to read accurately

The improved HICKOK meter scale is 2½ times longer than conventional meters to provide faster, more positive readings. Panel size 250° meters, pioneered by HICKOK, fit a smaller space, can be more easily read.

Accuracies to 1% of full scale reading! Available in popular AC or DC ranges. Case widths and diameters, 2½" to 5½". In reply kindly give details of your requirements.

THE HICKOK ELECTRICAL INSTRUMENT CO.
10587 DUPONT AVE. - CLEVELAND 8, OHIO
Highest Quality Electrical Meters Since 1910

S.S. WHITE FLEXIBLE SHAFTS GIVE YOUR TV SETS THIS EXTRA SALES APPEAL

Tuning Convenience

You can make channel change and reception regulation on your TV equipment an easy, effortless task, when you couple the tuning knobs to their respective circuit elements with S.S.White flexible shafts.

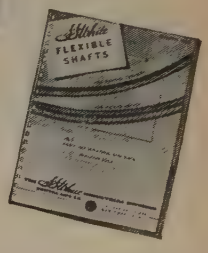
The shafts will provide the sensitivity you require and at the same time will remove all limitations on the location of the control knobs. They'll permit you to position the knobs on the top of the set, on the side or even in a remote location—wherever necessary to assure maximum convenience.

Take advantage of the extra selling features S.S.White flexible shaft couplings can give your sets. Check their possibilities today. For details,

S.S.White MAKES IT RIGHT

WRITE FOR NEW BULLETIN 5008

It contains the latest information and data on flexible shafts and their application. Write for a copy today.



THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. G-R 10 East 40th St.
NEW YORK 16, N. Y.

NEW TYPE 2200
SYNCHRONIZING
SIGNAL GENERATOR

Featuring:

A new high for stability, performance, versatility.

- All binary dividers. No blocking tube or locked oscillators. Complete freedom from "rolling" at critical moments.
- All waveforms keyed from pulses derived from precision delay line. Absolute stability is achieved.
- Meets all RMA and FCC specifications with wide margin to spare.
- Built-in bar and dot generator for sweep linearity checking.
- Furnished with cabinet and has 33¼" mounting space available for type #2300 monoscope camera or other uses.

Price Complete with Cabinet
$1995. F.O.B. PLANT

Write for Type 2200 Data Sheet for Full Details

Manufacturers of a Complete Line of TV Test Equipment
TIC Tel-Instrument Co. Inc.
50 PATERSON AVENUE • EAST RUTHERFORD, N. J.

LOST db LOCATED

MEASURE CONVERSION LOSS AND NOISE TEMPERATURE OF SILICON MIXER CRYSTALS

This portable self-contained instrument will indicate directly the conversion loss of all mixer crystals intended for use at or below 10,000 Mc. Above 10,000 Mc the readings are relative (crystals may be selected in the order of their quality). The instrument also indicates 30 Mc noise temperature. Conversion loss mean deviation ½ db; noise temperature mean deviation ½.

PRODUCTION TESTING
INCOMING INSPECTION
FIELD TESTING

Order AIL Type 390 $95.00 net
FOB Mineola, N. Y.

PAT. APP. FOR

AS SIMPLE TO USE AS A VOLTMETER

Airborne Instruments Laboratory
INCORPORATED
160 OLD COUNTRY ROAD, MINEOLA, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 71A)

New Preamplifier

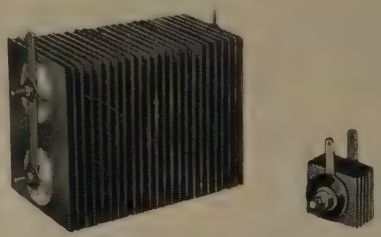
Model 230H, a new, compact, small size preamplifier to equalize low frequencies and provide necessary gain for magnetic pickups, has been developed by Pickering & Co., 308 Woods Ave., Oceanside, L. I., N. Y.

Model 230H is self-powered, operates with any high quality, high input impedance amplifier and installs by plugging in. This new preamplifier is said to be superior to most broadcast station equipment in its frequency response and accuracy of equalization; furthermore, its intermodulation and harmonic distortion is said to be lower than good engineering practice requires of professional equipment.

(Continued on page 74A)

SYNTRON

OFFERS



SELENIUM RECTIFIERS

—made by a new process to uniform, high quality. In extra large cell sizes as well as small cells.

Write for brochure.

SYNTRON CO.
242 Lexington, Homer City, Pa.

MODEL 60
Bolometer Amplifier

- Self Contained Metering
- Pull Out Meter
- AC and DC Recorder Output
- Panel Selection of 3 Frequencies
- Adjustable and Metered Bolometer Bias

USES

The Model 60 Bolometer Amplifier is a band pass amplifier designed to amplify the output of crystal or bolometer probes used in RF measuring equipment. The amplifier is suitable for all occasions where extremely low audio voltages must be amplified. The recorder output makes the unit particularly useful for antenna pattern recorders requiring either AC or DC input voltages.

DESCRIPTION

The Model 60 Bolometer Amplifier is an audio amplifier incorporating parallel 'T' null networks in a feed back circuit to provide a narrow band pass at any desired frequency within specified limits. The amplifier includes a meter amplifier and an output meter which may be removed from the panel opening for use at remote locations. The recorder output provides a choice of impedances for AC outputs as well as a DC output for those recorders requiring such an input. Input circuits are designed for operation with crystals or 300 ohm bolometers.

CHARACTERISTICS

FREQUENCY RANGE—400 cycles to 5000 cycles (choice of 1, 2, or 3 frequencies within these limits) ±2% frequency tolerance.

BANDWIDTH—(½ voltage points) 8% of bandpass center frequency.

INPUT VOLTAGE RANGE
Meter—10^{-2}–10^{-7} volt
Recorder (AC)—10^{-2}–10^{-6} volt

INPUT IMPEDANCE—250 ohm to 350 ohm.

METER—Logarithmic meter scale (0-20 db) with 100 db decade.

RECORDER OUTPUT—AC .01-100 volts @ 50,000 ohms. Additional output impedances of 5000 ohms, 500 ohms, and 250 ohms. DC—0.01-0.75 volts.

BOLOMETER BIAS—Adjustable in steps of 2% current change over a range 2:1—metered directly.

POWER SUPPLY—115 volts 50/60 cycles 40 watts.

DIMENSIONS—19" wide, 8¾" high, 10" deep.

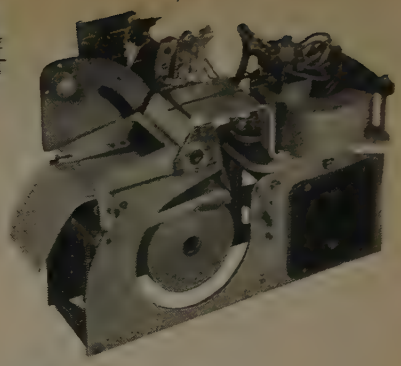
WEIGHT—27 lbs.

FINISH—Blue grey wrinkle panel and mahogany cabinet (unit may be rack mounted without cabinet if desired.)

Ask for Bulletin L-60

PICKARD and BURNS, Inc.
240 Highland Ave.
Needham 94, Mass.

DIRECT WRITING RECORDERS



Records are produced by a heated writing stylus in contact with heat sensitive paper. The paper is pulled over a sharp edge in the paper drive mechanism (standard speed 25 mm/sec., slower available) and the stylus wipes along this edge as it swings, thus producing records in *true rectangular coordinates*. The writing arm is driven by a D'Arsonval moving coil Galvanometer with an extremely high torque movement (200,000 dyne cms per cm deflection).

This recorder assembly may be obtained in bare chassis form, as illustrated (51-600) with or without built-in timer; or, with the addition of a stylus heating transformer, temperature controls, and control panel (127); or, with the entire assembly, controls and control panel enclosed in a mahogany carrying case (127C). Complete catalog available, see below.

SINGLE CHANNEL

NO INK
RECTANGULAR COORDINATES
PERMANENT RECORDS

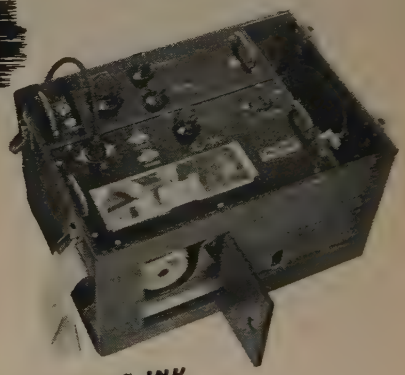
INSTRUMENT AMPLIFIERS

A general purpose, A.C. operated driver amplifier for use with model 127 Recorder, comprising three direct coupled push-pull stages. Maximum sensitivity 50 mv. per cm., minimum sensitivity 50 volts per cm., with four intermediate ranges. Balanced input terminals available with impedances of 5 megohms to ground. Complete information in catalog shown below.

Also available:

High Sensitivity STRAIN GAGE amplifiers

AMPLIFIER-RECORDERS

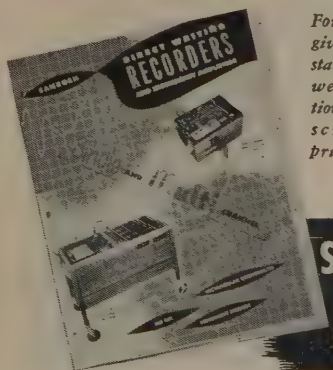


Model shown at right is a single channel unit comprising above Amplifier 126 and Recorder 127, contained in one mahogany carrying case, and designed for use in the industrial field as a direct writing vacuum tube recording voltmeter capable of reproducing any electrical phenomena from the order of a few millivolts to more than 200 volts. More complete data in catalog shown below.

At lower right is a typical "Poly-Viso" multiple channel direct writing Recorder and Amplifier in console. Numerous combinations of this recording equipment and associated amplifiers and accessories are available. The Multi-channel Recorder (Model 65) provides for the simultaneous registration of *up to four* input phenomena, using the same principles and method as for the Recorder Assembly above. In addition, the "Poly-Viso" Recorder provides a selection of eight paper speeds: 50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec., and for the use of 4, 2, or 1 channel recording Permapaper. The Amplifier equipment is housed in a rack which has space for four individual driver amplifiers (electrically identical to model 126, above) and one 4-channel preamplifier.

MULTI-CHANNEL

NO INK
RECTANGULAR COORDINATES
PERMANENT RECORDS

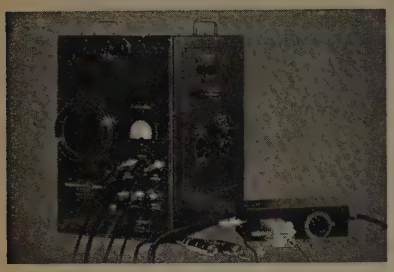


For complete catalog giving tables of constants, sizes and weights, illustrations, general description, and prices, address:

SANBORN COMPANY
Industrial Division
CAMBRIDGE 39, MASS.

Sanborn Recorders and Amplifiers have evolved from those originally designed by Sanborn Company for use in electrocardiographs, and have, by actual practice, proven to have wide applications in the industrial field as well.

Test Equipment FOR RADAR and PULSE APPLICATIONS



MODEL 705 WOBBULATOR

Swept signal output with center frequency adjustable from 2 to 500 mc.
Continuous swept output adjustable from 0 to 100 mc./sec. with 0.1 volt output at 50 ohms.
Internally synchronized scope with detectors and amplifiers.
High and low impedance shielded traveling detectors.
Output designed for making response measurements at 3000 mc., IF frequencies, and Video.

MODEL 708 SPECTRUM ANALYZER

Frequency range—8500 mc to 9600 mc.
Receiver—Double conversion superheterodyne.
IF bandwidth—approximately 10 kc.
Sweep frequency—10 cps to 25 cps.
Minimum frequency dispersion—1 mc/inch.
Maximum frequency dispersion—10 mc/inch.
Signal input attenuator—100 db linear.
Power—115V or 230V, 50 cps to 800 cps.

Write for complete technical data

Canoga Corporation

14315 Bessemer St., Van Nuys, Calif. • Box 361

Crystal Gazing
Electronics Style

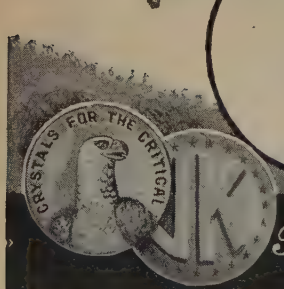
There's no room for "guess work" in the manufacture of crystals! That's why so many so often specify JK stabilized crystals when they want to be sure of utmost dependability.

Happily, this preference for the best costs no more. You, too, will be pleasantly surprised to find that The James Knights Company can furnish you outstanding quality at modest cost—in single units or production quantities.

JK Stabilized H17

Frequency range 200 kc to 100 mc. The pin spacing is such that two units can be mounted in a loctal socket. A small extremely light weight hermetically sealed unit. Moisture and dustproof. Designed especially for use where space is at a premium. The crystal is plated and wire mounted. Will stand maximum vibration. Pin diameter of the H17 is .050".

The H17L and the H17W are also available in the same frequency range except that the H17L has a pin diameter .093", and the H17W has wire leads.



The James Knights Company
SANDWICH, ILLINOIS

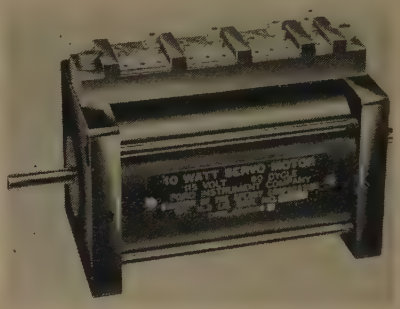
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 72A)

New Rotor For Low Inertia Servo Motor

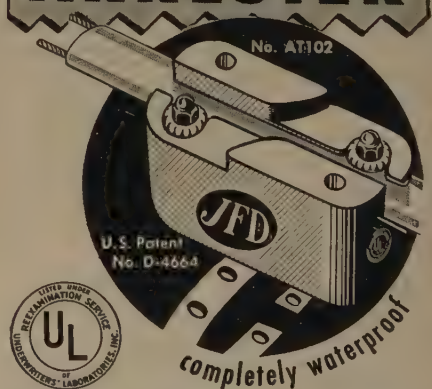
A new type 10-watt low inertia servo motor, having the highest torque-to-inertia ratio of any servo motor now available, it is claimed, has been developed by **Ford Instrument Co.**, 31-10 Thompson Ave., Long Island City 1, N. Y.



Ford engineers have developed a rotor of pure iron which is appreciably superior to copper bar rotors. Iron rotors completely eliminate "cogging" and "single phasing" inherent in some bar-type rotors, and permit a much smaller rotor.

(Continued on page 78A)

TWIN LEAD, TELEVISION
LIGHTNING ARRESTER



APPROVED for OUTDOOR-INDOOR Use
Protects Television Sets Against Lightning and Static Charges
$2.25

Twin Lead
JFD SAFE TV GUARD

Simple to install everywhere and anywhere ...no stripping, cutting or spreading of wires. More than 300,000 in use today!

SEE YOUR JOBBER OR WRITE TO

JFD MANUFACTURING CO., Inc.
6127 16th Avenue, Brooklyn 4, N. Y.
First in Television Antennas & Accessories

Dependable PERFORMANCE at LOWER COST

TOWER LIGHTING EQUIPMENT

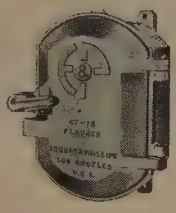
H & P lighting equipment, consistently specified by outstanding radio engineers, is furnished as standard equipment by most leading tower manufacturers.

300 MM CODE BEACON

Patented ventilator dome circulates the air, assures cooler operation, longer lamp life. Concave base with drainage port at lowest point Glass-to-glass color screen supports virtually eliminate color screen breakage. Neoprene gaskets throughout. CAA approved

MERCURY CODE FLASHER

Lifetime-lubricated ball bearings. No contact points to wear out. Highest quality bronze gears Adjustable, 14 to 52 flashes per minute



SINGLE and DOUBLE OBSTRUCTION LIGHTS

Designed for standard A-21 traffic signal lamps Prismatic globes meet CAA specifications.

"PECA" SERIES PHOTO-ELECTRIC CONTROL

Turns lights on at 35 f.c.; off at 58 f.c., as recommended by CAA. High-wattage industrial type resistors. Low-loss circuit insulation

ALSO COMPLETE LIGHT KITS FOR A-2, A-3, A-4 and A-5 TOWERS

PROMPT SERVICE and DELIVERY

First-day shipments out of stock. Immediate attention to specifications and unusual requirements

WRITE OR WIRE FOR CATALOG AND DETAILED INFORMATION

HUGHEY & PHILLIPS
TOWER LIGHTING DIVISION
326 N. LA CIENEGA BLVD.
LOS ANGELES 48, CALIF.
60 E. 42ND ST. NEW YORK 17, N. Y.

HE CHOSE

Magnecorder

Checking a second Magnecorder installation.

PT6-A Magnecorder and amplifier in rack mount. WGAR, Cleveland

THE FIRST CHOICE OF RADIO ENGINEERS

HIGH FIDELITY, LOW COST

Only Magnecord offers you such high fidelity at such low cost. Magnecorder frequency response: 50—15 kc ± 2 db. Signal-noise ratio: 50 db. Harmonic distortion less than 2%. Meets N. A. B. standards. More radio engineers use Magnecorders than all professional tape recorders combined!

GREATEST FLEXIBILITY

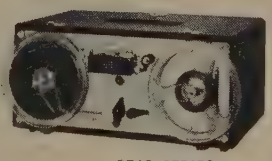
Mount a Magnecorder in a rack or console cabinet for delayed studio or network shows. Slip it into its really portable cases for remotes. Add to your Magnecord equipment as you need it—combine Magnecorders to suit every purpose.

MORE FEATURES

Your Magnecorder, new or old, now can have 3 heads (separate erase, record, and playback) to permit monitoring from tape. Three speeds (15"—7½"—3¾" —up to an hour on a 7" reel) available on both PT6 and PT63 equipment. Dual track heads also available if desired.

MAGNECORDER
For every purpose . . . every purse!

PT6 SERIES
Most widely used professional tape recorder in the world.



PT63 SERIES
Three heads to erase, record, and monitor from the tape.

PT7 SERIES
A complete console for only $950.00. Outstanding features and flexibility. Models for portable or rack mount also available.

Write for NEW CATALOG

MAGNECORD, INC., Dept. P-11
360 North Michigan Avenue, Chicago 1, Ill.
Send me latest catalog of Magnecord Equipment.

Name.....

Company.....

Address.....

City.....Zone..... State.....

The NEW *Berkeley* MODEL 1600

COUNTING RATE COMPUTER

gives you these important advantages:

1. Virtually instantaneous rate of response
2. Permanent printed record of counting rate
3. Operates from either binary or decade scaler

BRIEF SPECIFICATIONS

Designed specifically for tracer applications requiring faithful response to rapid changes in counting rate, the Model 1600 will operate from any scaler that can be made to provide successive output pulses after accumulation of predetermined count. Computer then converts elapsed time between successive output pulses into average counting rate. Counting rate can be read directly on visible meter of computer.

Choice of three recording rate ranges, in combination with proper scaling factors, permits selection of conditions for optimum statistical accuracy.

When designated as Model 1600A the unit includes standard recorder which provides permanent trace of counting rate.

FOR COMPLETE SPECIFICATIONS AND OPERATING DATA PLEASE WRITE FOR BULLETIN 1600IRE

Berkeley Scientific Company

P. O. BOX 1826 • RICHMOND, CALIFORNIA

SMALL

PARTS

Cost less when made by

MULTI-SWAGE

The economy way to get a million small parts similar to these —

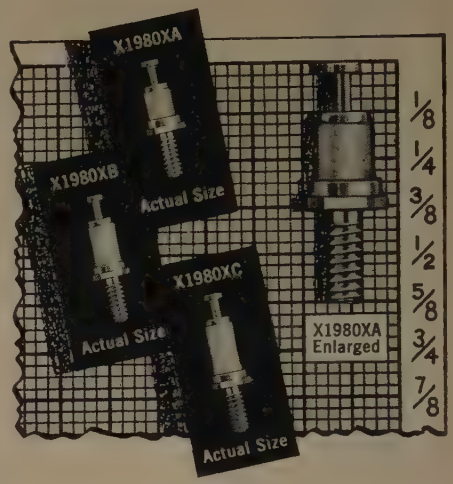
Examine the tubular metal parts shown here twice size. If you use anything similar . . . in quantities of over a million . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,

Tr. Mark 60 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

New Miniature Insulated Terminals

to help your miniaturization program



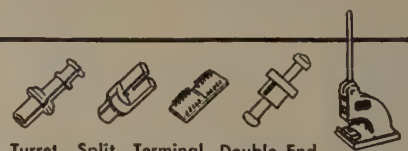
Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eighths of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .141" OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.



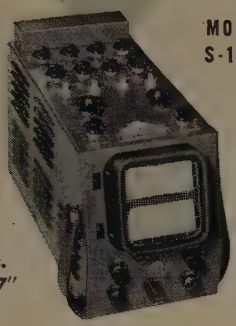
Turret Lugs | Split Lugs | Terminal Boards | Double-End Lugs | Swagers

custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
456 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

THE TWIN TUBE POCKETSCOPE®

BY WATERMAN



MODEL S-15-A

Wt. 16¼ lbs.
12" x 6" x 7"

A new concept in multiple trace oscilloscopy made possible by Waterman developed RAYONIC rectangular cathode ray tube, providing for the first time, optional screen characteristics in each channel. S-15-A is a portable twin tube, high sensitivity oscilloscope, with two independent vertical as well as horizontal channels. A "must" for investigation of electronic circuits in industry, school or laboratory.

Vertical channels: 10mv rms/inch, with response within —2DB from DC to 200kc, with pulse rise of 1.8μs. Horizontal channels: 1v rms/inch within —2DB from DC to 150kc, with pulse rise of 3μs. Non-frequency discriminating attenuators and gain controls, with internal calibration of traces. Repetitive or trigger time base, with linearization, from ½cps to 50kc, with ± sync. or trigger. Mu metal shield. Filter graph screen. And a host of other features.

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

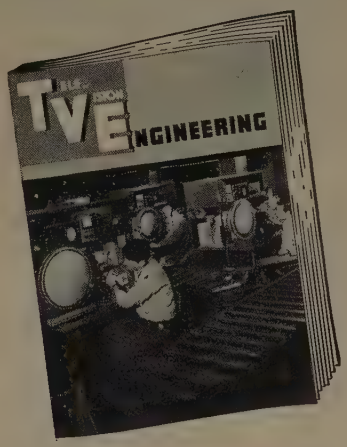
WATERMAN PRODUCTS INCLUDE:

S-10-B GENERAL POCKETSCOPE
S-11-A INDUSTRIAL POCKETSCOPE
S-14-A HI-GAIN POCKETSCOPE
S-14-B WIDE BAND POCKETSCOPE
S-21-A LINEAR TIME BASE

Also RAKSCOPES, LINEAR AMPLIFIERS, RAYONIC® TUBES and other equipment

WATERMAN PRODUCTS

. . . if you are commercially or professionally interested in TV, you must read



TELEVISION ENGINEERING every month!

Devoted exclusively to TV Research . . . Design Production . . . Operation Instrumentation

TELEVISION ENGINEERING is the *only* trade publication which directs its *entire* editorial content to executives and engineers who design, manufacture, operate and maintain television receiving and transmitting equipment—both commercial and educational.

Every issue is chock full of timely and thorough TV articles, authored by outstanding specialists. You'll find practical, carefully prepared reports and papers on such vital subjects as . . .

Color TV Systems . . . Ultrahigh Receiver-Transmitter Design Problems . . . Tube Production-Line Techniques . . . TV Broadcast Equipment . . . Camera Tube Research . . . Glass, Plastics and Metal in TV . . . TV Test Equipment in the Plant . . . Film Recording . . . Flying Spot Scanners . . . Tone Amplifiers for TV Films . . . Compact Motors for TV . . . TV Component Design . . . Mechanical Design Factors in Antennas . . . Quality Control Charting . . . Microwave Relays . . . Receiver and Transmitter Servicing . . . Production Aids . . . Instrument Activities . . . TV Sound Systems . . . Studio Lighting.

Enter your subscription NOW . . . Fill out the coupon below

TeleVision Engineering IRE-11-50
52 Vanderbilt Ave., New York 17, N.Y.

Here is my remittance for my subscription to TeleVision Engineering at the

SPECIAL RATE . . . 3 years (36 issues) only $5.

NAME .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

For our confidential records, open only to the Audit Bureau of Circulation, please supply the following information:

Occupation ..... Title .....

Department in which employed

☐ Operation ☐ Production ☐ Research

Employed by .....

Nature of Business .....

(State if TV Manufacturer, TV Broadcast Station, etc.)

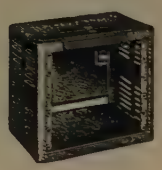
are "SPECIALS"? delaying your production?

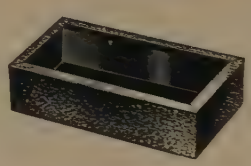
Your "SPECIAL" may be our "STOCK" item

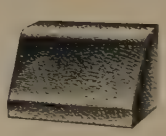
Whether you purchase sheet metal products or fabricate your own, it will pay you to check into our specialized production facilities, because you can often avoid costly delays when a SPECIAL is required.

We make over 400 different sheet metal products as stock items, any one of which may be just what you need. Often a slight change in one of our standard models will eliminate the necessity of special tools and dies, thereby reducing your cost. Since we produce thousands of sheet metal products every month for ourselves and for leading firms throughout the country, we are able to effect economies in production which mean lower prices and faster delivery.

Let us show you how you can save time and money on your sheet metal items today—send us your blue prints for estimates, or our representative will gladly call at your convenience.







BUD

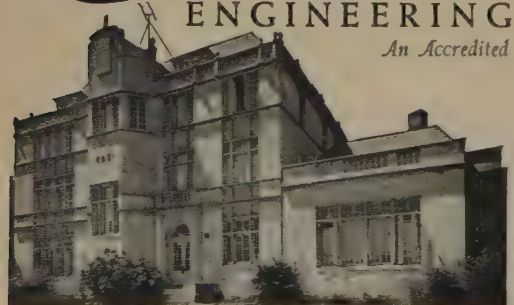
BUD RADIO, INC.

2110 EAST 55TH STREET CLEVELAND 3, OHIO

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute



ADVANCED HOME STUDY AND RESIDENCE COURSES IN PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING

Request your free home study or resident school catalog by writing to:

DEPT. 2611B
16th and PARK ROAD, N.W.,
WASHINGTON 10, D.C.
Approved for Veteran Training

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 74A)

The new 10-watt servo has a rotor diameter of only 0.665 inches, compared to 1.50 inches required in an equivalent servo having a copper bar rotor. This results in a saving of 1 pound in over-all weight, and a sevenfold increase in the torque to inertia ratio.

This servo can be foot- or flange-mounted, and the terminal block can be mounted in a choice of three positions.

Having linear torque speed characteristics over the entire operating range and a rotor inertia of 0.23 inches² ounces, this servo operates from either a single or 2 phase, 60 cps 115-volt supply, and can withstand indefinite stalling without damage.

Interesting Abstract

• • • **Inland Testing Laboratories, Inc.** 2745 N. Janssen Ave., Chicago 14, Ill. has released a new, 24-page brochure covering the test facilities, equipment, and capabilities they have to offer the industry for complete qualification testing of components and assemblies made under government contracts in accordance with JAN specifications.

New Phase Meter

A new precision phase meter, which provides means for determination of phase relationships throughout the audio spectrum of 30 to 20,000 cps, accurate to 0.1°,

is at present in production by **The W. L. Maxson Corp.**, 460 W. 34 St., New York 1, N. Y.

(Continued on page 79A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

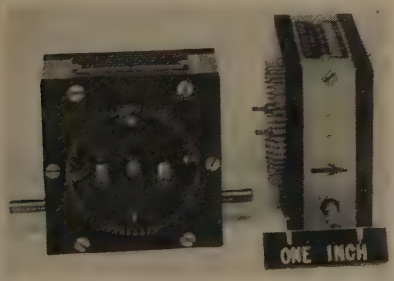
(Continued from page 78A)

This instrument measures phase difference in terms of the calibrated phase shift required to establish phase coincidence of the voltages in the measuring circuit. Phase angle is read from two decade dials and a zero-center meter having a full-scale range of ±1°. Switch-selected controls permit determination of lag or lead and of positive or negative "sense."

The power supply for the Model P-1060 electron-tube circuits is integral with the instrument chassis. It is designed to operate from an unregulated, 105/125-volt, 60-cps circuit.

High-Speed Multichannel Sampling Switch

The device illustrated, Model 2-60S-L high-speed multichannel sampling switch, a compact unit which weighs only 8½ ounces, is announced by **The Applied Science Corp.**, P.O. Box 44, Princeton, N. J. Dimensions are 2½ long 1½ wide×2½ inches high.



This miniature switch is designed with a 60:1 internal gear reduction and two separate poles, each of which contains 60 contacts. This design enables the two synchronized wipers to sample their respective contacts at a rate of one contact per revolution of the input shaft, thus permitting the user to correlate data from different channels with respect to angular position from a fixed reference for the drive shaft.

The shorting type-wipers allow great versatility in wiring arrangements with the possibility of having as many as 60 independent channels per pole for "make-before-break" switching and 30 per pole for "break-before-make" switching when alternate contacts are left unwired.

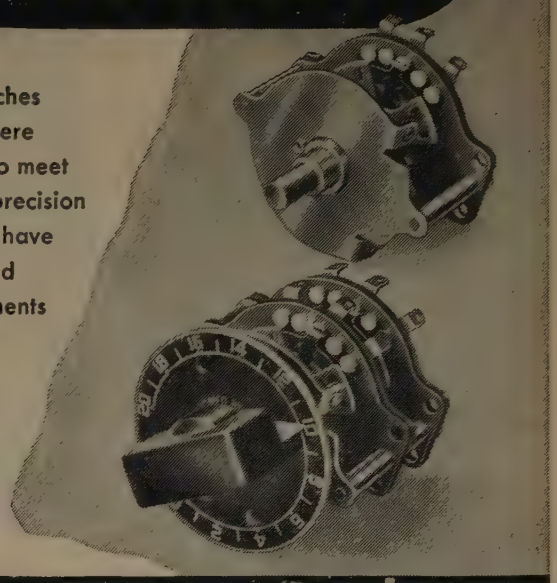
Similar switches are available with 30:1 and 15:1 internal gear reductions.

Inexpensive L-Pad for Special Applications

Clarostat Mfg. Co., Inc., Washington St., Dover, N. H., manufacturers of resistance devices, announce a new addition to their L-Pad line. The new L-Pad has been designed for special application work, where dependability and cost are prime requisites.

(Continued on page 80A)

New Type 2A TAP SWITCHES
HAVE A CONSTANT CONTACT RESISTANCE OF
ONLY 1 or 2 MILLIOHMS!



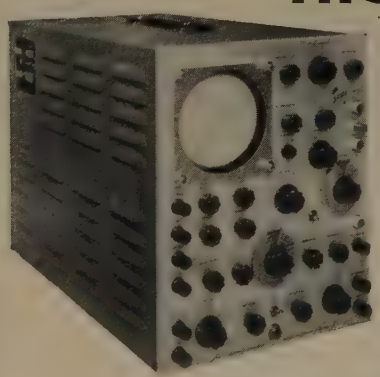
These high quality switches with up to 24 contacts were specifically developed to meet the need for rugged precision instrument switches that have longer operating life and are economical components in competitively priced electronic instruments and military equipment.

●

Write for Technical Bulletin No. 28.

TECH LABORATORIES PALISADES PARK NEW JERSEY

SLOW SWEEPS
HIGH SENSITIVITY



- *Band Pass—DC-2mc*
- *Sensitivity—5mv/cm maximum*
- *Sweeps—.3 sec/cm to 3 μsec/cm*

Type 512 Oscilloscope

Accurate observation and measurement of slowly recurring phenomena is difficult, if not impossible, by conventional oscilloscopic techniques. The Tektronix Type 512 Cathode Ray Oscilloscope, combining as it does direct-coupled amplifiers, slow sweeps and high accuracy, is recognized by a constantly increasing number of researchers as being an indispensable laboratory tool. New and fruitful approaches to the problems encountered in research are permitted by these features. *$950.00 f.o.b. Portland, Oregon.*

Write today for detailed specification of Type 512 and other Tektronix instruments.

TEKTRONIX, INC.

712 S.E. Hawthorne Blvd. Portland 14, Ore.

COSSOR for QUALITY

WHEN TIMING COUNTS . . . .
you can count on
Cossor Twin Beam Scopes

UNIQUE twin beam flat face tube permits EXACT time comparison of two waveforms without phase or frequency error. Beams are independent vertically and locked in horizontal direction, can be separated, superimposed or crossed for any comparative test . . . and . . .

Model 1035 TWIN BEAM SCOPE (illustrated) offers these additional features:

DIRECT time measurement on calibrated controls from 150 millisec. to 1 microsec. DIRECT voltage measurement on each beam from 500 volts to 1 millivolt.

Recurrent or triggered sweeps from 150 millisec. to 5 microsec. High gain, wideband amplifier, —3 db. at 7 Mc.

Write for details on Model 1428 Scope Camera for still or moving film records.

All instruments and spares in stock New York.

$465 fob Halifax
$650 fob New York

COSSOR (CANADA) LIMITED
301-303 Windsor Street, Halifax, N.S.
BEAM INSTRUMENTS CORPORATION
Room 907, 511 5th Avenue, New York 17, N.Y.

E-I HERMETIC SEALING COMPONENTS

Now Available!
An extended range of types and sizes in the popular
90-G SERIES
MULTIPLE HEADERS

90 G/40-HS-14
90 G/40-HS-8
90 G/P-9 (Noval)
90 G/P-7 (Miniature)
90 G/P-14
90 G/60-NS-12

The 90-G Series is now supplied in a wider range of types than ever before. These include 5 and 10 amp lead sizes with from 2 to 14 terminals as well as plug-in bases for miniature 7, noval 9, and special 14-prong sockets. Voltage ratings are 1600 peak.

Write for These Descriptive Bulletins:
849 — Hermetically Sealed Terminals
850 — Hermetically Sealed Headers
851 — Gasket Type Bushings

E-I INC
ELECTRICAL INDUSTRIES
INCORPORATED
44 SUMMER AVENUE • NEWARK 4, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 79A)

The new Type No. CM8727, 8 ohm L-Pad, is a single unit with two separate wire windings for maintaining constant impedance. It was designed primarily for PA uses. Its compactness of size, identical to

Clarostat's Type 43 control, 1⅛ diameter by 9/16 inch deep, its low cost, and rugged construction are some of the advantages offered in this control. It is available upon special order within impedance ranges from 6 to 300 ohms. Rotation of the control is 120°.

Random Noise Generator

The **Kay Electric Co.**, Maple Ave., Pine Brook, N. J., announces the Microwave Mega-Nodes, a series of random noise generators designed to produce a known output noise in the frequency range of 2,600 to 12,400 Mc.

They are a group of five separate noise sources, each utilizing a standard commercial fluorescent lamp in a JAN size waveguide, each mounted on a hardwood stand. A separate cabinet houses the power supply for the noise sources. Plug-in cables are provided for direct connection of the power supply to any one of the microwave units. The following waveguide sizes are available: RG48/U, RG49/U, RG50/U, RG51/U, and RG52/U. Over the operating range, the VSWR of each generator is less than 1.1, with the exception of the RG50/U guide whose VSWR goes to 1.19 over about 20 per cent of the frequency range. The noise output of each generator is 15.84 db above thermal noise at a waveguide temperature of 32° C.

(Continued on page 81A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 80A)

Null Detector Amplifier

A new null detector amplifier Model No. 1140 has just been introduced by **Freed Transformer Co., Inc.,** 1718-36 Weirfield St., Brooklyn (Ridgewood) 27, N. Y.

This instrument is a high gain selective ac operated null indicator used for bridge measurements. It provides visual null indications or aural indications when used in conjunction with head phones. This unit may also be used as a high gain amplifier for general laboratory work..

(Continued on page 82A)

NEW WIDE BAND D.C. AMPLIFIER

MODEL 120

A precision instrument designed for use as a preamplifier in conjunction with an oscilloscope, vacuum tube voltmeter or other instruments.

SPECIFICATIONS

FREQUENCY RESPONSE: Within ± 1 db between D.C. and 100,000 cycles per second.

GAIN: Approximately 100.

INPUT CONNECTION: Double channel, can be used for single ended and push-pull signals or as a differential amplifier.

INPUT IMPEDANCE: One Megohm shunted by approximately 15mmf in each channel.

DUAL INPUT ATTENUATOR: One to one, 10 to one, 100 to one and "off" positions in each channel independently adjustable.

OUTPUT CONNECTION: Push-pull or single ended.

OUTPUT IMPEDANCE: Less than 50 Ohms single ended or 100 Ohms push-pull.

HUM AND NOISE LEVEL: Below 40 microvolts referred to input.

LOW DRIFT due to regulated heater voltage in input stage.

MOUNTING: Metal cabinet approximately 7" wide by 7" high by 11" deep.

Write for descriptive literature on the Model 120 D.C. Amplifier and other Furst laboratory instruments including Regulated Power Supplies.

FURST ELECTRONICS

14 S. Jefferson St., Chicago 6, Ill.

All-Metal...

All-Weather

MOUNTS

COMPLETE and BALANCED PROTECTION

(CUP TYPE MODEL #7002)

MET-L-FLEX

Unit mounts and mounting systems with MET-L-FLEX provide vibration isolation and true shock absorption through the widest range of operating conditions. All-metal • no organic materials • stable characteristics from −90° C. to +175° C. • wide load tolerance • built-in damping for stability and reduced amplification at resonance.

For electronic or delicate equipment mounting, write Dept. 814 MET-L-FLEX Data Sheets available.

ROBINSON AVIATION INC.

TETERBORO, NEW JERSEY

Vibration Control Engineers

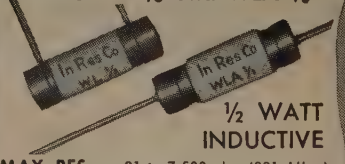
***IN-RES-CO* offers a complete line of standard RESISTORS that meet practically every requirement . . . . Prompt Quotations supplied on both standard and special types**

—more compact, higher accuracy!

Economical in Cost

IN-RES-CO WL series resistors were designed to meet increasing demands for a compact resistor of high accuracy priced for general use. They meet the most critical requirements — close tolerance, ability to withstand overload, long life. Write for catalog.

TYPES WL 5/8 and WLA 5/8



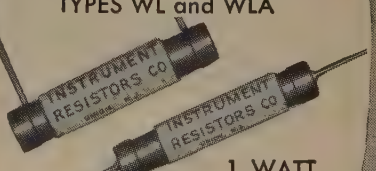
½ WATT INDUCTIVE

MAX. RES: .01 to 7,500 ohm (331 Alloy)
.01 to 4,000 ohm (Nichrome)
.01 to 1,250 ohm (Manganin)

BODY SIZE: 5/8" lg. by 3/16" diam.

TOLERANCE: STANDARD 1%

TYPES WL and WLA



1 WATT INDUCTIVE

MAX. RES: .01 to 15,000 ohm (331 Alloy)
.01 to 8,000 ohm (Nichrome)
.01 to 2,500 ohm (Manganin)

BODY SIZE: 1" lg. by 3/16" diam.

TOLERANCE: STANDARD 1%

Can be supplied non-inductive with one-half indicated maximum resistance.

IN-RES-CO APPLICATION-DESIGNED RESISTORS

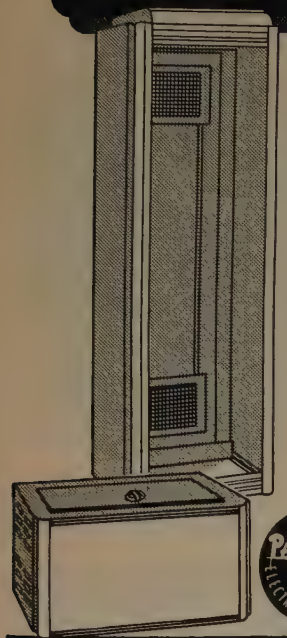
IN-RES-CO

INSTRUMENT RESISTORS CO., 1036 COMMERCE AVE., UNION, N. J.

CABINETS • CHASSIS • PANELS • RACKS

Planning ELECTRONIC EQUIPMENT?

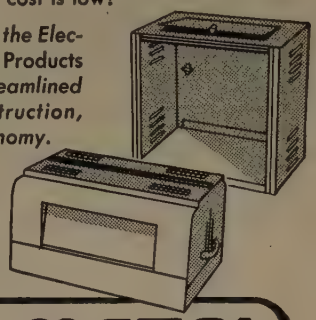
Investigate the ECONOMIES of PAR-METAL HOUSINGS!



We manufacture Metal Housings for every purpose — from a *small receiver* to a *deluxe broadcast transmitter*. And the cost is low!

Because we *specialize in the Electronics field*, Par-Metal Products excel in *functional streamlined design, rugged construction, beautiful finish*, and *economy*.

Remember, Par-Metal equipment is made by *electronic specialists*, not just a sheet metal shop.



PAR-METAL

PRODUCTS CORPORATION

32-62 — 49th ST., LONG ISLAND CITY 3, N. Y.

Export Dept.: Rocke International Corp.

13 East 40 Street, New York 16, N. Y.

WRITE FOR CATALOG!

Available Now!

Easy, Fast Ultrasonic Spectrum Analysis WITH MODEL SB-7 PANORAMIC ULTRASONIC ANALYZER

USES

- Ultrasonic Vibration Measurements
- Harmonic Analysis
- Cross Modulation Studies
- Noise Investigations
- Determining Transmission Characteristics of Lines and Filters
- Monitoring Communications Carrier Systems
- Checking Interference, Spurious Modulation, Parasitics, Effects of load changes, shock, humidity, component variations, etc. upon frequency stability
- Telemetering

SPECIFICATIONS

Frequency Range: 2KC—300KC stabilized linear scale

Scanning Width: Continuously variable from 200KC to zero

Four Input Voltage Ranges: 0.05V. to 50V. Full scale readings from 1 millivolt to 50 volts

Amplitude Scale: Linear and two decade log

Amplitude Accuracy: Within 1db. Residual harmonics suppressed by at least 50db.

Resolution: Continuously variable. 2KC at maximum scanning width, 500c.p.s. for scanning widths below 8KC

WRITE NOW For Complete Information, Price and Delivery

An invaluable new direct reading instrument for simplifying ultrasonic investigations, the SB-7 provides continuous high speed panoramic displays of the frequency, amplitude and characteristics of signals between 2KC and 300KC. The SB-7 allows simultaneous observation of many signals within a band up to 200KC wide. Special control features enable selection and highly detailed examination of narrower bands which may contain signals separated by less than 500c.p.s. The instrument is unique in that it provides rapid indications of random changes in energy distribution.

PANORAMIC RADIO PRODUCTS Inc.

10 SOUTH SECOND AVE. MOUNT VERNON, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 81A)

The input impedance is 1 megohm in parallel with 25 $\mu\mu$f. Gain is 98 db with 1 megohm load (6 $\mu\mu$f shunt capacity) down 1.5 db at 25,000 cps, down 5 db at 50,000, and down 2 db at 20 cps. The null detector sensitivity: at 1 kc, 100 microvolts will give a 15 per cent meter deflection. Selective amplifier: 23 db second harmonic attenuation at 60 cps, 400 cps, and 1,000 cps. Output impedance is approximately 50,000 ohms. Output voltage is 40 volts undistorted into 1-megohm load, and 10 volts into 20,000 ohms.

Plant Expansion

Acme Electric Corp., 44 Water St., Cuba, N. Y., has begun construction of a new 25,000-square foot building to increase production of their line of transformers.

The new plant will be located at Allegany, N. Y., according to Charles H. Bunch, president of the firm.

TV Monitor

A new off-the-line TV monitor for use in viewing programs in control rooms, film rooms, clients' and announcers' booths and executives' offices, has been announced by the **Raytheon Manufacturing Co.**, 190 Willow St., Waltham 54, Mass.

(Continued on page 84A)

HIGHEST QUALITY ELECTRONIC COMPONENTS

Large Quantities in Stock for Immediate Delivery

RELAYS TUBES

TRANSFORMERS CHOKES

VOLUME CONTROLS RECTIFIERS

WIRE & CABLE TUBE SOCKETS

RESISTORS (WIRE WOUND, CARBON, etc.)

CONDENSERS (MOLDED, CERAMIC, OIL FILLED, etc.)

SWITCHES (TOGGLE, MINIATURE, WAFER, etc.)

All standard brands, inspected and guaranteed by Wells Sales.

Manufacturers: Write for complete Electronic Catalog and prices. Dept. P

WELLS SALES, INC.

320 N. LA SALLE ST.
CHICAGO 10, ILL.

MICROWAVE

23,000 TO 27,000 MC. BENCH TEST PLUMBING ½" x ¼" WAVEGUIDE

PRECISION SLOTTED LINE. Adjustable probe $200.00
DIRECTIONAL COUPLER-WAVEMETER MOUNT, 12DB $60.00
PRECISION VARIABLE ATTENUATOR, mfg. Bernard Rice $90.00
LOW POWER LOAD $20.00
SHUNT TEE $35.00
WAVEGUIDE LENGTHS, 2" to 6" long, goldplated with circular flanges and coupling nuts .....$2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS32 .....$49.50
Mitered Elbow, cover to cover $4.00
TR-ATR Section, choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover ..$4.50
Adaptor, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" $1.00 per ft.
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB $49.50 ea.
3J31 Magnetrons $55.00

8500 Mc. to 9600 Mc. Bench Test Plumbing 1" x 1½" WAVEGUIDE

FLAP ATTENUATOR, DB385. Maximum Attenuation 10DB $25.00
UNI-DIRECTIONAL COUPLER, DB390, 23DB type "N" output $18.50
PICK UP HORN, Type "N" output $4.50
WAVEMETER, 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type $85.00
WAVEGUIDE LENGTHS, Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections .....$2.00 per ft.
90 DEGREE ELBOWS, E or H plane, 2¾" radius $12.50
MITERED ELBOWS, E plane $10.00
90 DEGREE TWIST, 6" long $8.00
BULKHEAD FEED—THRU ASSEMBLY $15.00
PRESSURE GAUGE SECTION. 15 lb. gauge and press. nipple $10.00
PRESSURE GAUGE, 15 lbs. $2.50
DUAL OSCILLATOR-BEACON MOUNT, P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields $42.50
DUAL OSCILLATOR MOUNTS, (Back to back) with crystal mount, tunable termination, attentuating slugs $18.50
KLYSTRONS 723AB $12.00

X BAND

Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Rotary Joint Choke to Choke $17.50
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50

1¼" x ⅝" WAVEGUIDE

TUNABLE TERMINATION, Precision adjust $65.00
LOW POWER TERMINATION $25.00
MAGIC TEE $45.00
OSCILLATOR MOUNT, for four 723AB klystron $38.50
90 DEGREE ELBOWS, E or H plane $12.50
WAVEGUIDE LENGTHS, Cut to size and supplied with 1 choke, 1 cover, per length $2.00 per ft.
WAVEMETER: Absorption type, Precision micrometer adjust. Very high Q $150.00
Bi-Directional Coupler "N" Output $18.50
Mitred 90° Elbows H Plane $14.00
Flex Sections Rubber Coated 12" $15.00
Waveguide to "N" Adapter $18.50

4000 to 6000 mcs. Bench Test Plumbing 2" x 1" WAVEGUIDE

SLOTTED LINE, DeMornay type 332 complete with probe, etc. $600.00
FLAP ATTENUATOR $48.00
VARIABLE STUB TUNER AND LOW POWER TERMINATION $48.00
WAVEMETER TEE $48.00
ADAPTERS:
Choke to choke $18.00
Cover to cover $14.00
Choke to cover $16.00
WAVEGUIDE TO TYPE "N" ADAPTER $45.00
DIRECTIONAL COUPLER, Two hole type, type "N" output $48.00
KLYSTRON MOUNT, Equipped with tunable termination and micrometer adjust, klystron antenna tuning $110.00
CRYSTAL MOUNT, Equipped with tunable termination and micrometer adjust crystal tuning $125.00
TUNABLE TERMINATION, Precision adjust $90.00

6000 Mc. to 8500 Mc. Bench Test Plumbing

1½" x ¾" WAVEGUIDE
KLYSTRON MOUNT, DB356 complete with shield and tunable termination $125.00
FLAP ATTENUATOR, DB361 .....$45.00
VARIABLE STUB TUNER $90.00
WAVEGUIDE TO TYPE "N" ADAPTER $18.50
WAVEMETER TEE, DB352 .....$32.50
MAGIC TEE $80.00
DIRECTIONAL COUPLER, Two hole 25DB coupling, type "N" output $25.00
PRECISION CRYSTAL MOUNT, Equipped with tuning slugs and tunable termination $125.00
TUNABLE TERMINATION, Precision adjust $70.00
LOW POWER LOAD $35.00

MICROWAVE ANTENNAS

RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4' x 3' rectangle, new $35.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam. 115 v.a.c. drive. New $100.00
DBM ANTENNA, Dual, back-to-back parabolas with dipols. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00
AS125/APR, Cone type receiving antenna, 1080 to 3208 megacycles. New $4.50
140-600 MC CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50
ASD 3 cm, antenna, used, ex. cond. $49.50
YAGI ANTENNA AS-46A, APG-4, 5 elements .....$14.50 ea.
DISH FOR PARABOLA 30" $4.85
AS17/APS 10 CM Antenna, APS-2 30 Inch Dish with ⅞ Coax Dipole and fittings. New and Compl. with 24 V DC Drive motor, selsyn, 360 Deg. Rotation and Vertical Tilt $94.50

COUPLINGS—UG-CONNECTORS

UG 40/U	$.75	UG 52	$1.35	UG 55/U	$.40	UG/15U	$.75
UG 40A	$1.10	UG 210	$1.85	UG 56/U	$.75	UG206U	$.90
UG 343	$2.35	UG 212	$2.40	UG 65/U	$6.50	UG87U	$1.25
UG 344	$3.00	UG 40U	$.70	UG 149/U	$3.00	UG27U	$1.69
UG 425	$2.00	⅞ Coax	$.50	UG 148/U	$4.00	UG21U	$.89
UG 116	$1.95	⅞ Coax	$.95	UG 150/U	$3.00	UG167U	$2.25
UG 117	$2.50	UG 53/U	$.40	UG 39/U	$.60	UG29U	$.90
UG 51	$1.00	UG 54/U	$.40	UG 40/U	$.80	UG254U	$1.69

RADAR SYSTEMS AND COMPONENTS IN STOCK

APS-2
10 CM AIRBORNE
APS-3
3 CM AIRBORNE
APS-4
3 CM AIRBORNE
APS-6
3 CM AIRBORNE
APS-6A
3 CM AIRBORNE
APS-10
3 CM AIRBORNE
APQ-13
3 CM AIRBORNE
APS-15
3 CM AIRBORNE
APS-31
3 CM AIRBORNE
CPN-8
10 CM GROUND BEACON
CEXH
10 CM GROUND BEACON
FD-MARK 4
800 MC SHIP GUNLAYING
MARK-10
10 CM SHIP GUNLAYING
SA
200 MC SHIP AIR SEARCH
SC
200 MC SHIP AIR SEARCH
SD
200 MC SUBMARINE
SE
10 CM SURFACE SEARCH
SF
10 CM SURFACE SEARCH
SG
10 CM SURFACE SEARCH
SJ
10 CM SUBMARINE
SK
200 MC AIR SEARCH
SL
10 CM SURFACE SEARCH
SN
10 CM PORTABLE
SO (ALL SERIES)
10 CM SURFACE SEARCH
SQ
10 CM PORTABLE
SW
200 MC PORTABLE
SCR 518
400 MC ALTIMETER
SCR 520
10 CM AIRBORNE
SCR 533
200 MC AIR SEARCH
SCR 545
10 CM TRACKING 800 MC SEARCH
SCR 663
SEARCHLIGHT TRACK

SONAR SYSTEMS AND COMPONENTS IN STOCK

QBF
QBG
QC
QCJ
QCL
QCO
QCS
QCU
WEA

3000 MC BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type, Type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

R. F. EQUIPMENT

LHTR, LIGHTHOUSE ASSEMBLY, Part of RT-39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice .....$47.50 ea.

S. BAND

Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount, Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOORNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting or two 10 cm waveguide sections, each polarized, 45 degrees ..$75.00 per set
POWER SPLITTER: 726 Klystron input dual "N" output ..$5.00
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated .....$2.00 ea.

7" RIGID COAX

Magnetron Coupling with TR Loop, gold-plated $7.50
Sperry Rotating Bend, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length ..$7.50
Short Right Angle Bends (for above) $2.50

ARMY-NAVY TEST SETS

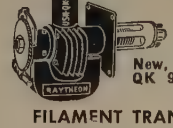
LU-1 Freq. Meter and Test Oscillator. Type CRV-TVN-9HU Power Supply. M.I.T. Rad. Lab.
TVN-8SE Klystron Power Supply. M.I.T. Rad. Lab.
CS60ABW Watt Meter—Wavemeter. 3 centimeter.
APR5 Receiver—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope, 115V AC input.

TEST EQUIPMENT

Dehydrator Unit CPD 10137 Automatic cycling.
Compressor to 50 lbs. Compl. for Radar XSMIN. Line New $425.00
SO-3 Receiver, 30 mc. IF. 6 stages 6AC7, 10 MC. Band width input. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc in ch. 13 vol. 23 M.I.T. Rad. Lab. Series $99.50
APS-2 10 CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser, 714 magnetron 417A Mixer at ⅞" rigid coax. incl. revr. front end ..$210.00
10 cm. cavity type wavemeters 6" deep, 6½" in. diameter Coax. Output Silver Plated..$64.50 ea.
10 cm. echo box. Part of SPI Radar W/115 volt DC Tuning motor Sub Sig. 1118AO..$47.50
TS12 3 cm Slotted Line
TS13 3 cm Signal Generator
TS33 3 cm Frequency Meter
TS35 3 cm Signal Generator
TS36 3 cm Power Meter
TS45/AMP3 3 cm Signal Generator
TS62 3 cm Echo Box
TS108 Dummy Load

PULSE TRANSFORMERS

G.E.K.-2745 .....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage, 3.23 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¾ microsec. @ 600 PPS $39.50
W.E. #D166173 Hi-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc. to 2 mc. 2 sections parallel connected, potted in oil $36.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1.2 is 1.1:1, and between terminals 6-7 and 1.2 is 2:1 Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. #K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms Pulse Width: 1 Microsec. Pri. Input: 9:5 KV PK Sec. Output: 28 KV PK. Peak Output: 800 KW Riflar 2.75 Amp. $64.50
W.E. #D169271 Hi Volt input pulse Transformer $27.50
G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV Peak power out 100 KW G.E..$34.50
G.E. #K2748A. Pulse Input line to magnetron $36.00
#9262 Utah Pulse or Blocking Oscilator XFMR Freq. limits 790-810 cy-3 winding turns ratio 1:1:1 Dimensions 1 13/16 x 1¼" 19/32 .....$1.50
Pulse 131-AWP L-421435 ...$6.00
Pulse 134-BW-2F L-440895..$2.25
RAY-WX-4298F $93.50
GE-K6324730 .....$50.00
GE-K921945 .....$50.00



"CW" MAGNETRONS

QK 62	3150-3375 mc.
QK 59	2675-2900 mc.
QK 61	2975-3200 mc.
QK 60	2800-3025 mc.

New, Guaranteed ....Each $65.00
QK 915 .....$150.00

FILAMENT TRANSFORMER

for above 115V/60 cy Pri: four 6.3V/4A Sec. 5000VT $27.50
Magnetron Kit of four QK's 2675-3375 inc, w/trans special $250.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$ 8.90
5200	21/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons .....$24.50 ea.
GE Magnets type M7765115, GI Distance Between pole faces variable, 2 1/16" (1900 Gauss) to 1¼" (2200 Gauss) Pole Dia. 1⅝". New Part of SCR 584 .....$34.50

MAGNETRONS		2J61	706
2J27			
2J31	2J62	KLYSTRONS	
2J21-A	3J31	723A	
2J22	5J30	707B W/Cavity	
2J26	2I4AY	417A	
2J32	718DY	2K41	
2J37	720BY	"CW" MAGNETRONS	
2J38	720CY	QK 62	3150-3375 mc.
2J39	725-A	QK 59	2675-2900 mc.
2J40	730-A	QK 61	2975-3200 mc.
2J49	728	QK 60	2800-3025 mc.
2J34	700	QK 9915	

THERMISTORS

D-167332 (tube) $.95
D-170396 (bead) ..$.95
D-167613 (button)..$.95
D-164699 for MTG in "X" band Guide $2.50
D-167018 (tube) ..$.95

VARISTORS

D-170225 .....$1.25
D-167176 .....$.95
D-168687 .....$.95
D-171812 .....$.95
D-171528 .....$.95
D-168549 .....$.95
D-168442 .....$3.00
D-165593 .....$1.25
D-98836 .....$2.00
D-161871A $2.85
D-171121 .....$.95
D-162356(308A) .$1.50
D-163357 .....$2.00
D-99946 .....$2.95

NEW TEST EQUIPMENT IN STOCK

1-185A Oscillator
1-158 Range Calibrator
1-223 Range Calibrator
BC 438 Freq. Meter
RF Preamp.
G.R. Capacity Brdg. $216
G.R. Uni Galvo Shunt $229
G.R. 100 SL Aud. Osc. $213
TS226A/AP Pwr. Mtr. O-1000 W.
Sig. Gen. #804 8-330 MC

All merch. guar. Mail orders promptly filled. All prices, F.O.B., N.Y.C. Send Money Order or Check. Only shipping charges sent C.O.D. Rated Concerns send P.O.

COMMUNICATIONS EQUIPMENT COMPANY

13 LIBERTY STREET, NEW YORK, N.Y. DEPT 111 P. J. PLISHNER PHONE DIGBY—9-4124

AND SO IS Seletron

SELETRON "Safe Center" plates in miniature rectifiers eliminate the danger of arc-over, short circuits and excessive heating due to high leakage current at the center contact point. Assembly pressure, or pressure applied in mounting the rectifier cannot affect its performance. This SELETRON feature is accomplished by deactivating the area of the plate under the contact washer.

There are *millions* of SELETRON Selenium Rectifiers in service in radio and TV; millions more in other electronic circuits. That is why you can specify SELETRON and be *safe!*

Look for Howard W. Sam's Red Book Supplement listing SELETRON replacements . . . and write for your copy of our new Bulletin No. RE-5

SELETRON DIVISION
RADIO RECEPTOR COMPANY, Inc.
Since 1922 in Radio and Electronics
Factory: 84 North 5th St., Brooklyn 11, N. Y. • Sales Department: 251 West 19th St., New York 11, N. Y.

CONTINUOUSLY
VARIABLE FILTERS
MODEL 302
VARIABLE ELECTRONIC FILTER

"Another SKL first"

The — SKL — Model 302 includes two independent filter sections, each having a continuously variable cut-off range of 20 cps to 200 KC. Providing a choice of filter types each section has 18 db per octave attenuation. When cascaded 36 db is obtained in the high and low pass setting and 18 db in the band pass position. With low noise level and 0 insertion loss this versatile filter can be used as an analyzer in industry and the research laboratory or to control sound in the communications laboratory, radio broadcasting, recording and moving picture industries.

SPECIFICATIONS

- CUT-OFF RANGE 20 cps to 200 KC
- SECTIONS 2—can be high, low and band pass
- ATTENUATIONS 36 db/octave maximum
- INSERTION LOSS . 0 db
- NOISE LEVEL 70 db below 1 volt
- FREQUENCY RESPONSE 2 cps to 2 MC

SKL SPENCER-KENNEDY LABORATORIES, INC.
181 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 82A)

This monitor, the MTV-12, is designed for professional use; all controls are located on the front panel and are quickly available to the operating personnel.

In addition to a 12½-inch picture tube, the unit contains an audio channel and speaker which may be used for either cueing or monitoring.

(Continued on page 85A)

NOW!
SPEED UP ALL SOLDERING WITH
UNGAR
FEATHER-LIGHT SOLDERING PENCILS WITH
HI-HEAT
INCREASED WATTAGE
TIPS

For use with No. 776 Handle & Cord Set

Stop wrestling with *big* irons. New HI-HEAT TIPS in your Ungar Electric Soldering Pencil produce a really versatile tool that'll perform on a par with the big, bulky 100-150 watt irons. If you can't get immediate delivery, please be patient, for production hasn't yet caught up with demand. Ask your supplier for No. 1236 Pyramid or No. 1239 Chisel. List price, $1.25 each.

Ungar ELECTRIC TOOL CO., Inc.
LOS ANGELES 54, CALIFORNIA

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 84A)

Recent Catalogs

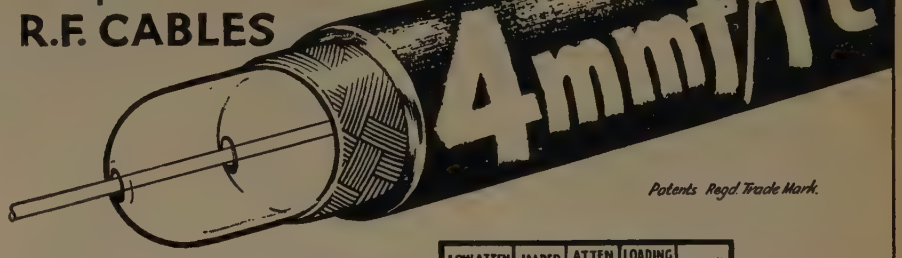
• • • **Polarad Electronics Corp.,** 100 Metropolitan Ave., Brooklyn 11, N. Y., is issuing a new 14-page catalog on TV cameras, synchronizing generators, monitors, TV amplifiers, and power supplies for broadcast operation.

• • • Technical and application data on precious metal alloys being used for sliding contacts, brushes, wipers, slip rings, commutator segments, resistance wire, and noncorrosive wear-resistant parts may be obtained from **The J. M. Ney Company,** 71 Elm St., Hartford, Conn.

• • • The September, 1950, issue of *CEC Recordings*, with various articles on instrumentation, includes an article on a new Model 21-103 mass spectrometer with a new ion source, Isatron, and is available from **Consolidated Engineering Corp.,** 620 N. Lake Ave., Pasadena 4, Calif.

• • • A new bulletin CS, with numerous line drawings and charts to give information concerning contact switches relative to sizes, designs and materials available in standard contact blades, lug adapters, and insulating separators may be obtained from **Guardian Electric Mfg. Co.,** 1621 W. Walnut St., Chicago 12, Ill.

Only with CO-AX air-spaced articulated R.F. CABLES



Potents Regd Trade Mark.

THE LOWEST EVER CAPACITANCE OR ATTENUATION

We are specially organised to give SPOT DELIVERIES TO U.S.A *Cable your rush order for shipment by air freight. Settlement by your own $ check*

LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft at 100 Mc/s.	LOADING Kw Mc/s.	O.D."	
A1	74	1.7	0.11	0.36	
A2	74	1.3	0.24	0.44	
A34	73	0.6	1.5	0.88	HIGH POWER FLEXIBLE
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C1	7.3	150	2.5	0.36	
PC1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C11	6.3	173	3.2	0.36	
C2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	V.L.C. ★
C44	4.1	252	2.1	1.03	

★ Very Low Capacitance cable.

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD · LONDON SW7 ENGLAND
CABLES: TRANSRAD LONDON

The New STAVER MINI-SPRING
TRADE MARK REG. AND PAT. PEND.

A quality Tube Guard that is Bargain Priced

Gives support two ways—Keeps pressure downward and gives sideway support. The spring action is constant and resilient permanently. Send for catalog sheet.

THE Staver COMPANY INCORPORATED
91 PEARL ST. • BROOKLYN 1, N. Y.
ULSTER 5-6303

PRODUCTION LINE TESTING OF SERVOMECHANISMS

SERVOSCOPE

SERVO CORPORATION OF AMERICA
NEW HYDE PARK
LONG ISLAND
NEW YORK

INVALUABLE IN RESEARCH
RAPID INSPECTION ON THE PRODUCTION LINE

A SERVO ANALYZER

- STANDARD RANGE: .1 TO 20 CYCLES PER SECOND
- SINE WAVE
- SQUARE WAVE
- MODULATED CARRIER
- READS DIRECTLY
- 50 TO 800 CYCLES
- SERVO LAG OR LEAD IN DEGREES

PROFESSIONAL CARDS

LESTER W. BAILEY
Registered Patent Agent
Senior Member IRE
PATENT OFFICE PRACTICE specializing in
ELECTRONICS MECHANICS
RADIO
LINCOLN-LIBERTY BUILDING
PHILADELPHIA 7
Broad & Chestnut Streets Rittenhouse 6-3267

ALFRED W. BARBER LABORATORIES
Specializing in the Communications Field and in Laboratory Equipment
Offices, Laboratory and Model Shop at:
32-44 Francis Lewis Blvd., Flushing, L.I., N.Y.
Telephone: Independence 3-3306

HAROLD J. BROWN
Vibrators
Vibrator Power Supplies
Electrical Contact Systems
Mattapoisett, Mass.

W. J. BROWN
International Electronics Consultant
AT PRESENT IN GREAT BRITAIN
Will undertake assignments for American or British Clients. Please address inquiries to 11 Public Square, Cleveland 13, Ohio.
TO 1-6498 FA-1-0030

EDWARD J. CONTENT
Acoustical Consultant
Functional Studio-Theater Design
FM — Television — AM
Audio Systems Engineering
Roxbury Road Stamford 3-7459
Stamford, Conn.

CROSBY LABORATORIES, INC.
Murray G. Crosby & Staff
Radio-Electronic Engineering,
Research & Development
FM, Communications, TV
Test Equipment
Offices, Laboratory & Model Shop at:
126 Herricks Rd., Mineola, N.Y.
Garden City 7-0284

ELK ELECTRONIC LABORATORIES
Jack Rosenbaum
Specializing in the design and development of
Test Equipment for the communications, radar and allied fields.
333 West 52nd St. Telephone:
New York 19, N.Y. PLAZA 7-0520

PAUL GODLEY CO.
Consulting Radio Engineers
P.O. Box J. Upper Montclair, N.J.
Offs & Lab.: Great Notch, N.J.
Phone: Montclair 3-3000
Established 1926

HERMAN LEWIS GORDON
Registered Patent Attorney
Patent Investigations and Opinions
Warner Building 100 Normandy Drive
Washington 4, D.C. Silver Spring, Md.
National 2497 Shepherd 2433

HOGAN LABORATORIES, INC.
John V. L. Hogan, Pres.
APPLIED RESEARCH, DEVELOPMENT, ENGINEERING
Est. 1929. Exceptionally competent staff. Electronics, Optics, Mechanisms, Facsimile Communication, Electro-sensitive recording media, Instrumentation.
155 Perry Street, New York 14 CHelsea 2-7855

MEASUREMENTS CORP.
RESEARCH & MANUFACTURING ENGINEERS
Harry W. Houck Jerry B. Minter
John M. van Beuren
Specialists in the Design and Development of Electronic Test Instruments
BOONTON, N.J.

Eugene Mittelmann, E.E., Ph.D.
Consulting Engineer & Physicist
High Frequency Heating—Industrial Electronics
Applied Physics and Mathematics
549 W. Washington Blvd. Chicago 6, Ill.
State 2-8021

PICKARD AND BURNS, INC.
Consulting
Electronic Engineers
240 HIGHLAND AVE.
NEEDHAM, MASS.

PAUL ROSENBERG ASSOCIATES
Consulting Physicists
Main office: Woolworth Building, New York 7, N.Y.
Cable Address PHYSICIST Telephone WOrth 2-1939
Laboratory: 21 Park Place, New York 7, N.Y.

SERVO CORPORATION OF AMERICA
Henry Blackstone, President
Consultants on Electronic Control Problems for Industry
New Hyde Park Long Island, N.Y.

TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS CONSULTANTS
RADIOTELETYPE - FREQUENCY SHIFT
INK SLIP RECORDING - TELETYPE NETWORKS
121 Spencer Place, Mamaroneck, N.Y.

WHEELER LABORATORIES, INC.
Radio and Electronics
Consulting — Research — Development
R-F Circuits — Lines — Antennas
Microwave Components — Test Equipment
Harold A. Wheeler and Engineering Staff
Great Neck, N.Y. Great Neck 2-7806

WILLIAM L. FOSS, INC.
927 15th St., N.W. REpublic 3883
WASHINGTON, D.C.

INDEX AND DISPLAY ADVERTISERS

Section Meetings 38A
Student Branch Meetings 38A
Membership 40A
Positions Open 50A
Positions Wanted 56A
News-New Products 30A

DISPLAY ADVERTISERS

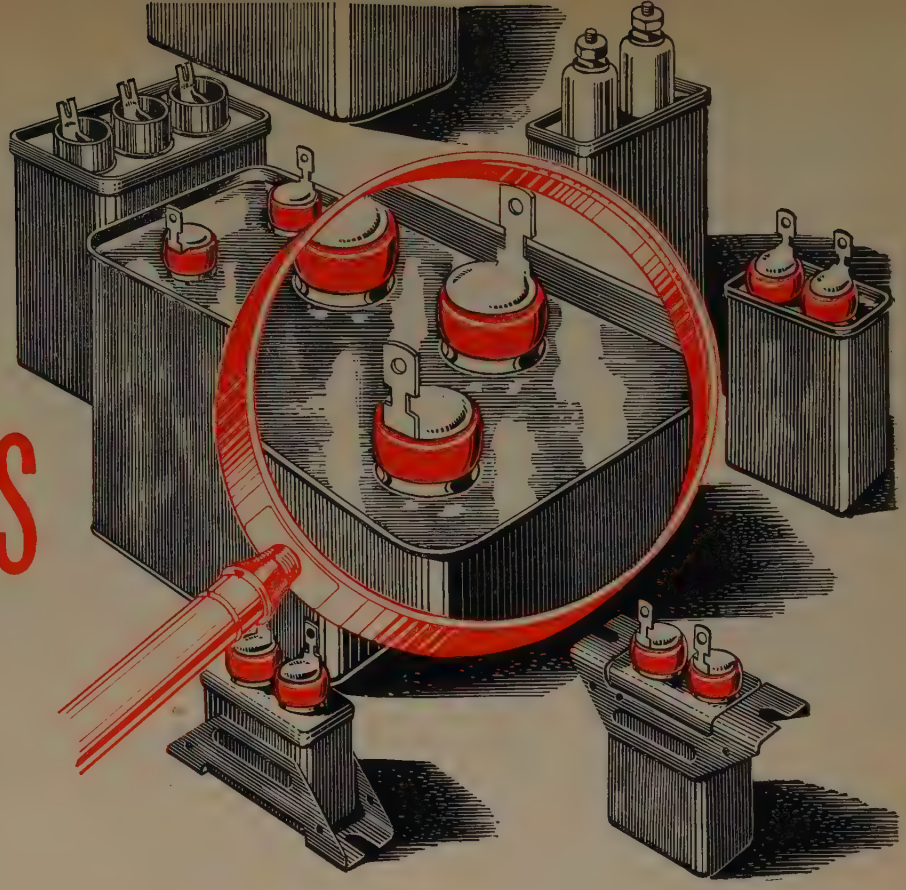
Ace Engineering & Machine Co., Inc. 65A
Acme Electric Corp. 65A
Aerovox Corp. 22A
Airborne Instruments Lab., Inc. 52A, 72A
Aircraft Radio Corp. 16A
Airtron, Inc. 44A
Allied Electric Products, Inc. 43A
American Lava Corp. 17A
Amperex Electronic Corp. ..... Cover II
Antara Products, Div. of General Aniline & Film Corp. ..... 46A & 47A
Arnold Engineering Co. 6A

Lester W. Bailey 86A
Ballantine Labs. 40A
A. W. Barber Labs. 86A
Barker & Williamson 38A
Bead Chain Mfg. Co. 76A
Bell Telephone Labs. 2A
Bendix Aviation (Friez Inst. Div.) 56A
Bendix Aviation (Pacific Div.) 62A
Bendix Aviation (Radio Div.) 52A
Berkeley Scientific Co. 76A
Blaw-Knox 67A
Harold J. Brown 86A
W. J. Brown 86A
Bud Radio, Inc. 78A

Cambridge Thermionic Corp. 76A
Canoga Corp. 74A
Capitol Radio Engineering Inst. 78A
Centralab 33A, 34A, 35A, 36A
Cleveland Container Co. 9A
Sigmund Cohn Corp. 69A
Collins Radio Co. 41A
Communication Products Co. 48A
Communications Equipment Co. 83A
E. J. Content 86A
Convair 54A
Cornell-Dubilier Electric Corp. ..... Cover III

Capacitors

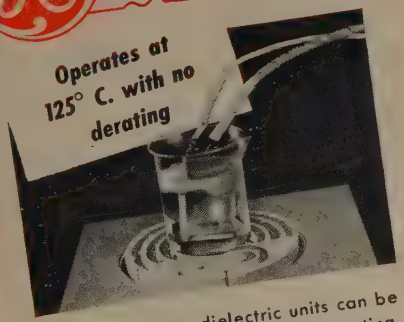
sealed for Life with G-E silicone rubber



SILICONE—the amazing new synthetic that made headlines when General Electric brought it out—is back in the news again. For today, G-E small capacitors, up through 5000 volts, are hermetically sealed with G-E silicone rubber bushings or gaskets.

This means that your new G-E capacitor is sealed positively, permanently—for maximum life. For silicone seals by compression alone, without the use of adhesives. It will never shrink, loosen or pull away—it remains elastic at any operating temperature a capacitor will ever meet. It is impervious to oils, alkalies and acids. Its dielectric strength is permanently high and it is not easily damaged during installation for it has a flexibility that withstands mechanical and thermal shock.

This exclusive G-E feature—designed to surpass established installation requirements—makes General Electric capacitors finer and more dependable than ever before. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



These d-c paper-dielectric units can be used up to 125° C. without derating. The impregnant is Permafil which retains its excellent insulating properties at these high temperatures.

Available in case styles 53, 61, 63 and 65. Ratings are up to 2 muf and 400 volts, D.C.

Please address all inquiries to Capacitor Sales Div., General Electric Co., Pittsfield, Mass.

Silicone-rubber bushings, permanently elastic and formed to close tolerances, seal themselves by compression to the capacitor cover. They are used with capacitors 1500-v d-c, or 660-v a-c, and lower. Silicone rubber gaskets with plastic or porcelain stand-offs are used for higher voltages.

GENERAL ELECTRIC

407-172

specify Sorensen

AC VOLTAGE REGULATORS

MODEL NO. 500-S

Accuracy, with rugged construction, economical and trouble-free operation, reasonable cost — those are features that you expect, *and get,* when you specify Sorensen regulators!

ALL SORENSEN REGULATORS HAVE THESE ADVANTAGES:

- WIDE INPUT RANGE
- ADJUSTABLE OUTPUT VOLTAGE THAT STAYS SET
- REGULATION ACCURACY OF ± 0.1%
- EXCELLENT WAVEFORM
- FAST RECOVERY TIME
- INSENSITIVITY TO LINE FREQUENCY FLUCTUATIONS.

STANDARD AC SPECIFICATIONS

VA capacity	150 500	250 1000	2000 3000	5000 10000 15000
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
Regulation accuracy	± 0.1% against line or load			
Input voltage	95-130 VAC; also available for 190-260 VAC single phase 50-60 cycles			
Output voltage	Adjustable between 110-120; 220-240 in 230 VAC models			
Load range	0 to full load			
P.F. range	Down to 0.7 P.F. All models temperature compensated			

NOTE: THREE PHASE AND 400 CYCLE REGULATORS ALSO AVAILABLE. ALL REGULATORS CAN BE HERMETICALLY SEALED.

Write for Complete Literature

For regulated DC problems investigate Sorensen's line of Voltage Reference Standards, DC Supplys, and NOBATRONS

Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTERS; VOLTAGE REFERENCE STANDARDS; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

SECTION MEETINGS

AKRON

"X-Ray Measurements in Instruments," by Robert Gager, Victoreen Instrument Corporation; September 19, 1950.

"Man and Computer," by G. L. Landsman, Bureau of Standards; October 17, 1950.

ATLANTA

Business Meeting; June 30, 1950.

"The Conduct of the Business of The Institute of Radio Engineers," by Ben Akerman, Regional Director, Region 6; September 29, 1950.

BALTIMORE

"FM versus AM for VHF Marine Communication," by L. W. Lynn, General Electric Company; October 11, 1950.

BEAUMONT-PORT ARTHUR

Films: "Stepping Along With Television," and "Telephone Screen Review"; September 22, 1950.

"Industrial Radar for Tracking Hurricanes," by A. T. Deere, Dow Chemical Company; October 4, 1950.

BOSTON

"The Digital Computer as an Information Processing System," by J. W. Forrester, Massachusetts Institute of Technology; September 28, 1950.

BUFFALO-NIAGARA

"Electronics in Defense Against Atomic Attack," by Seville Chapman, Faculty, Cornell Aeronautic Laboratory; September 20, 1950.

CEDAR RAPIDS

"A Sixty-Six Million Electron Volt Proton Linear Accelerator," by W. G. Shepherd, Faculty, University of Minnesota; September 26, 1950.

CINCINNATI

"Photo Electric Organ," by Ted Jones, Baldwin Company; September 19, 1950.

CLEVELAND

Informal Meeting; September 29, 1950.

CONNECTICUT VALLEY

"Recording and Reproduction of LP Microgroove Records," by W. S. Bachmann, Columbia Records, Inc.; "A Wideband Cathode Follower," by William Von Winkle, Graduate Student, Yale University; September 21, 1950.

DALLAS-FORT WORTH

"1000 Ft. TV-FM Antenna," by Stuart Wilson, International Derrick Company; September 29, 1950.

DENVER

"Cosmic Ray Research on Mt. Evans," by Mario Iona, Faculty, University of Denver; October 13, 1950.

EMPORIUM

"Instrumentation in Modern Geophysics," by R. D. Wycoff, Gulf Oil Company; September 22, 1950.

EVANSVILLE-OWENSBORO

"A New Three Tube Single Side Band Transmitter," by D. E. Norgaard, General Electric Company; September 20, 1950.

"Test Equipment for Pulse, EHF, UHF, VHF, and Audio Frequencies," by Frank Waterfall, Alfred Crossley Associates; October 11, 1950.

HOUSTON

"Computations and Measurements on RF Transmission Lines," by C. V. Clarke, Radio Station KPRC-KXYZ; October 17, 1950.

(Continued on page 40A)

NEW! FREQUENCY AND TIME MEASUREMENTS ACCURATELY . . . CONVENIENTLY

FREQUENCY RATIO MEASUREMENTS

DIRECT RPM READING TACHOMETER

SECONDARY FREQUENCY STANDARD

using $f = \frac{n}{t}$

ANY FACTOR MAY BE MEASURED FOR FIXED VALUE OF THE OTHER

FREQUENCY MEASUREMENTS

TIME INTERVAL MEASUREMENTS

TOTALIZING COUNTER

The Universal 6-IN-ONE MEGACYCLE FREQUENCY-TIME COUNTER

Now, the Potter Instrument Company offers all-in-one equipment, the features heretofore available only in separate counting systems. Two complete counting channels, a 100 kc crystal oscillator time base and unique gating circuits are combined to provide the new FREQUENCY-TIME COUNTER.

by Potter

FREQUENCY MEASUREMENTS	0 to 1 mc range by counting cycles per pre-selected time or by measuring time per pre-selected count. Accuracy 0.001 % minimum.
TIME INTERVAL MEASUREMENTS	0 to 10 seconds ± 10 micro-seconds.
FREQUENCY RATIO MEASUREMENTS	Ratio of two external frequencies can be measured.
SECONDARY FREQUENCY STANDARD	100 kc crystal oscillator with divided frequencies available at 10, 1 kc and 100, 10, 1 cps.
TOTALIZING COUNTER	Six decades, pulses 0 to 1 mc, sine wave 10 cps to 1 mc.
DIRECT RPM READING TACHOMETER	Through the use of an external 60 count per revolution photoelectric disc generator an accuracy of ± 1 rpm is obtained.

FEATURES

WIDE FREQUENCY RANGE — Pulses 0 to 1 megacycle — sine waves from 10 cps to 1 mc.

EXTREMELY HIGH ACCURACY — 0.001% from 0 to 1 megacycle.

VERSATILITY — Frequency measurements, time intervals, frequency ratios, high speed counting, rpm measurements, and a secondary frequency standard — all in one instrument.

RAPID MEASUREMENT — No adjustments or interpolations — only a few seconds for a complete measurement.

DIRECT DECIMAL READING — Frequency or time displayed on six Potter Counter Decades using the 1-2-4-8 large neon glow lamp decimal indication. Readable even under high ambient illumination.

AUTOMATIC OR MANUAL RECYCLING — The counter will retain the measurement until reset or will automatically recycle after displaying the measurement for a selected time.

NO ADJUSTMENT — Stable decade counter frequency dividers, rather than multivibrators are used to establish the precise time base.

DEPENDABLE — The exclusive four-lamp Potter decades provide a direct on-off indication of the counter stages without the complexity and unreliability of a readout matrix. An associated glow lamp for each tube in the counting and dividing circuits simplifies tube servicing.

PERMANENT RECORD — Other versions of the Frequency Time Counter can be supplied with high speed recording devices. (Dept. 5-D)

INSTRUMENT Potter COMPANY

POTTER INSTRUMENT COMPANY

INCORPORATED

115 CUTTER MILL RD., GREAT NECK, NEW YORK

MORE GEO. STEVENS COIL WINDING EQUIPMENT IS IN USE THAN ALL OTHER MAKES COMBINED!

• **MORE OUTPUT . . . LOWER COSTS** . . . from *EXCLUSIVE* SPEED FEATURE. Universal motors permit variable speeds without changing belts and pulleys. Coil design permitting, speeds as high as 7500 RPM are not uncommon.

• **PORTABILITY.** Conveniently carried from place to place. Machines come mounted on bases to constitute one complete unit.

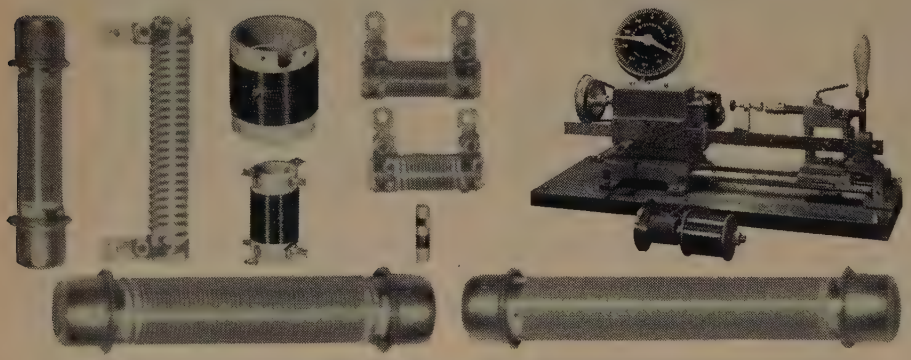
• **MUCH LOWER ORIGINAL COST.** The same investment buys more GEO. STEVENS machines than any other coil winding machines.

• **LONG LIFE.** Most of the original GEO. STEVENS machines bought 14 years ago are still operating daily at full capacity.

• **MUCH FASTER CHANGING OF SET-UPS** than any other general purpose coil winding machine. Quickly changed gears and cams save time between jobs.

• **VERY LOW MAINTENANCE.** Replacement parts are inexpensive, can be replaced in minutes, and are stocked for "same day" shipment, thus saving valuable production time.

• **EASIEST TO OPERATE.** In one hour, any girl can learn to operate a GEO. STEVENS machine.



SPACE WINDING MACHINE, MODEL 30, winds resistors and space wound coils up to 6" long. Winds wire from No. 40 to 18. For smaller wire sizes, Model 92-6 De-Reeler is recommended instead of the bench type spool holder illustrated.

8 to 800 TURNS PER INCH is an *outstanding feature,* permitting an unusually wide range of pitch selection. 48 pitch change gears—completely enclosed for safety—give desired pitch. Up to 10,000 turns are registered by full vision 6" Clock Dial Counter.

For speedy return to starting position, the heavy traverse bar has a friction drive and uses a rack and pinion for return. Accurate location for start of coil is attained by screw adjustment on feed roller. Fine wire is wound freely and fast due to ball bearing, spring tension tailstock which also allows quick change of coil forms. Spools and tailstock may be adjusted closer or farther from winding head by moving tension bracket—because they are mounted on bed rods. Tailstock may also be moved to the front or rear for perfect alignment.

Motor equipment: ¼ H.P. Variable Speed Universal Motor with foot treadle control. Automatic Stop with Predetermined Counter is optional—it saves time and eliminates most bad coil rejection by not requiring operator to do turns manually.

Also available—MODEL 35—same construction, same features but arranged to wind forms up to 12" long.

There is a GEO. STEVENS machine for every coil winding need. Machines that wind ANY kind of coil are available for laboratory or production line. . . . Send in a sample of your coil or a print to determine which model best fits your needs. Special designs can be made for special applications. Write for further information today.

World's Largest Manufacturer of Coil Winding Machines

REPRESENTATIVES

Frank Tatro
6022 No. Rogers Ave., Chicago 30, Illinois
Ralph K. Reid
1911 W. 9th St., Los Angeles 6, California
R. A. Staff & Co.
1213 W. 3rd St., Cleveland 13, Ohio

GEO. STEVENS MFG. CO., INC.
Pulaski Road at Peterson
Chicago 30, Illinois

SECTION MEETINGS

(Continued from page 38A)

INDIANAPOLIS

"Lecture and Demonstration of Test Equipment for Pulse, UHF and Audio Measurements," by Frank Waterfall, Alfred Crossley and Associates; October 12, 1950.

KANSAS CITY

"Industry Report"; January 24, 1950.

"The Interaction of Electrons and Electromagnetic Field Multicavity," by Chai Yeh, Faculty, University of Kansas; February 15, 1950.

Student Paper Competition; April 11, 1950.

"Solar and Cosmic Noise," by C. R. Burrows, Faculty, Cornell University; Election of Officers; May 5, 1950.

"Television Network Facilities of the Bell System," by M. E. Strieby, American Telephone and Telegraph Company; September 21, 1950.

"Flush Mounted Travelling Wave Antennas," by D. K. Reynolds, Faculty, Stanford Research Institute; September 22, 1950.

LOS ANGELES

"Co-Channel Sky Wave Recording," by Mal Mobley, Jr., Radio Station KMPC; "Automatic Methods in Ultrasonic Flaw Detection," by George Greene and Don Erdman, Electro-circuits Company; "Electronics in the Chemical Industry," by Howard Carey, Applied Physics Corporation; October 3, 1950.

MILWAUKEE

"More Waves—More Words—Less Wire," by Dr. Perrine, American Telephone and Telegraph Company; September 20, 1950.

NEW MEXICO

"Airborne Antennas," by H. A. Schutz, Glenn L. Martin Company; August 25, 1950.

"The Mathematical Training of Electrical Engineers," by Alexander Boldyreff, Faculty, University of New Mexico; September 22, 1950.

NEW YORK

"The Engineer's Approach to the Human Mechanism," by J. R. Ragazzini, Faculty, Columbia University; September 6, 1950.

NORTH CAROLINA-VIRGINIA

"Television Planning, Installation, and Proof of Performance Test," by W. L. Braun, Radio Station WSEA; September 29, 1950.

OTTAWA

"Importance of the Loudspeaker in Sound Reproduction," by G. J. Thiesen, Acoustics Laboratory, N.R.C.; October 19, 1950.

PHILADELPHIA

Business and Social Meeting; October 5, 1950

PORTLAND

"The Growth of Professional Groups to More Effectively Disseminate Information on Institute Affairs," by A. V. Eastman, Regional Director, The Institute of Radio Engineers; May 5, 1950.

"Metal Plate Lenses for Microwave," by J. J. Brady, Faculty, Oregon State College; May 20, 1950.

"Modern Transmission Methods in Electrical Communication," by Ralph Bown, Bell Telephone Laboratories; May 22, 1950.

"Design of a Regulated Frequency Power Supply for Use in Bell System Time Announcing Machines," by H. M. Owendoff, Bell Telephone Laboratories; June 22, 1950.

"BPA Microwave System," by D. E. Smith, Bonneville Power Administration; "FTL Equipment," by N. J. Gottfried, Federal Telecommunications Laboratories; Inspection Tour conducted by R. J. Hughes, Federal Telecommunications Laboratories; September 21, 1950.

(Continued on page 42A)

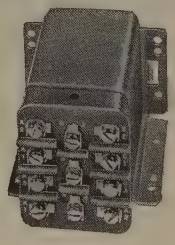
SERIES 610 A.C. AND SERIES 615 D.C.

One of a line

Relays BY GUARDIAN

CHRISTMAS OR CONVOYS . . . For peacetime products or national defense—let Guardian be your first line supplier.

The Guardian 610 A.C. and 615 D.C. Relay shown above is small and low priced, yet packed with power. Furnished hermetically sealed with the Screw Terminal housing shown, Octal Plug, or A.N. Connector housing.



The Guardian Hermetic Seal Screw Terminal Housing

Write — ASK US TO MAKE SPECIFIC RECOMMENDATIONS. NO OBLIGATION.

GUARDIAN ELECTRIC

1628-P W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

INSTRUMENTS THAT BELONG IN *Your* LABORATORY

Type 310-A Z-Angle Meter — 30 to 20,000 c.p.s.

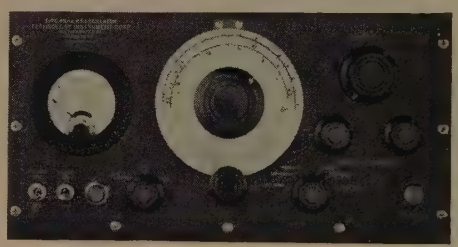
Measures impedance directly in polar coordinates as an *impedance* magnitude in ohms and *phase angle* in degrees $Z/\pm\ominus$. Measures, with equal ease, pure resistance, inductance, capacitance or complex impedances comprised of most any RLC combinations. Range: Impedance (Z), 0.5 to 100,000 ohms; Phase Angle ($\ominus$), +90° (X_L) through 0° (R) to —90° (X_C). Accuracy: Within ± 1% for impedance and ± 2° for phase angle. Price: $470.00.

Type 311-A R-F Z-Angle Meter for radio frequencies — 100 kc to 2 mc.

Simplifies laboratory and field *impedance* and *phase angle* measurements. Ideal for checking impedance of coils, transformers, coupling networks, lines, filters, antennas, etc. Direct-reading Impedance Range: 10 to 5,000 ohms up to 200 kc, and 10 to 1,000 ohms at 1 mc. Phase Angle: +90° (X_L) through 0° (R) to —90° (X_C). Accuracy: Impedance to within ± 3%, and phase angle ± 4°. Price: $385.00.

Type 410-A R-F Oscillator — 100 kc to 10 mc. (Special models 46.5 kc to 4.65 mc available.)

Power oscillator for use as bridge driver and general laboratory measurements. Features: High stability, high output (approximate 30 volts), 50-60 Ω output impedance, expanded frequency scale, direct reading output voltmeter, compact design. Price: $385.00.



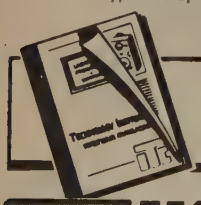
Type 320-A Phase Meter — frequency range 20 cycles to 100 kc.

The *first* commercially available all-electronic instrument that directly measures the phase angle between two voltages *in a simple* operation. Ideally suited to applications in such fields as audio facilities, ultrasonics, servomechanisms, geophysics, vibrations, acoustics and many others.

Phase angle readings made directly without balancing . . . stable at frequencies as low as 2 to 3 cycles. Voltage range: 1 to 170 peak volts. Terminals for recorder . . . choice of relay-rack or cabinet mounting. Price: $525.00. Cabinet: $25.00.

Type 110 Slide-Wire Resistance Box

Convenient combination consisting of precision decade resistor and continuously adjustable slide-wire which provides smooth, continuous variation of resistance between decade steps (permits adjustment of resistance to one part in 10,000). For most applications, eliminates need for more elaborate multi-dial decade boxes. Ideal for student and general laboratory use. Decade resistance cards adjusted to within ± 0.1% of nominal values, and slide-wire resistors direct-reading to within 1% of their maximum values. Cast aluminum cabinet. All resistance elements completely enclosed. Suitable for use at audio and ultrasonic frequencies. Type 110-A, range 0-11,000 ohms: $47.00. Type 110-B, range 0-110,000 ohms: $49.50.



Technical catalog—yours for the asking. Contains detailed information on all TIC Instruments, Potentiometers and other equipment. Get your copy without obligation—write today.

TECHNOLOGY INSTRUMENT CORP.

1058 Main Street, Waltham 54, Massachusetts

Engineering Representatives *Cleveland, Ohio PRospect 6171*

Representatives and Telephone Numbers

Cleveland, Ohio—PRospect 1-6171 Chicago, Ill.—UPtown 8-1141 Dallas, Tex.—DIxon 9918
Rochester, N.Y.—Genesee 3547-M Cambridge, Mass.—ELiot 4-1751 Canaan, Conn.—Canaan 649
Hollywood, Cal.—HOllywood 9-6305 Boonton, N.J.—BOonton 8-3097 Manhasset, N.Y.—MAnhasset 7-3424 Dayton, Ohio—MIchigan 8721

SECTION MEETINGS

(Continued from page 40A)

"Signalling Equipment Used in Long Distance Automatic Dialing," by L. B. Edwards, Pacific Telephone and Telegraph Company; October 19, 1950.

SALT LAKE

"Type K Carrier System," by W. M. Stuart, American Telephone and Telegraph Company; Tour of KSL-TV Studios; October 16, 1950.

SAN ANTONIO

"Relationship of the Regional Director to the Sections," by Ben Akerman, Radio Station WGST; "Microwave Atmospheric Refractometer," by A. P. Deam, Faculty, University of Texas; September 21, 1950.

SAN DIEGO

"Guided Missile Electronics," by D. P. Tucker, U. S. Navy Electronics Laboratory; September 5, 1950.

SCHENECTADY

"Electronics in Navigation Control," by R. L. Wanamacher, General Electric Company; October 2, 1950.

SEATTLE

"Control of Loudspeaker Bass Response," by W. R. Hill, Faculty, University of Washington; September 29, 1950.

SYRACUSE

"The Bell Telephone Laboratory and Its Work," by J. W. McRae, Bell Telephone Laboratories; October 5, 1950.

TOLEDO

Films: "Mobile Telephone" and "Radar and Sonar," by Ohio Bell Telephone Company; September 12, 1950.

TORONTO

"Master Control Equipment for a Large Broadcasting Studio Center," by R. H. Tanner, Northern Electric Company; October 2, 1950.

VANCOUVER

"Institute Affairs," by A. V. Eastman, Faculty, University of Washington; Election of Officers; September 19, 1950.

WASHINGTON

"A New Coupling Circuit for Audio Amplifiers," by F. H. McIntosh, McIntosh Engineering Laboratory, Inc.; October 9, 1950.

WILLIAMSPORT

"Television Synchronizing Circuits," by N. S. Kornetz, Westinghouse Radio Division; September 27, 1950.

SUBSECTIONS

AMARILLO-LUBBOCK

"Vertical Antennas," by George McBride, Radio Station KFDA; May 23, 1950.

"Noise Figure Measurements," by J. E. Masterson, Faculty, Texas Technological College; September 6, 1950.

BINGHAMTON

"Radio Shielding, Principles and Practice," by C. F. Maylott, Bendix Corporation; September 28, 1950.

CENTRE COUNTY

"Radar in the Next War," by G. L. Haller, Faculty, Pennsylvania State College; Election of Officers; May 22, 1950.

"The Polarimeter, Its Use in Studying Low Frequency Echoes," by H. J. Nearhoff, Radio Propagation Laboratory; "Relays: Their Place in the Modern Power System," by L. G. McCracken, Faculty, Pennsylvania State College; October 17, 1950.

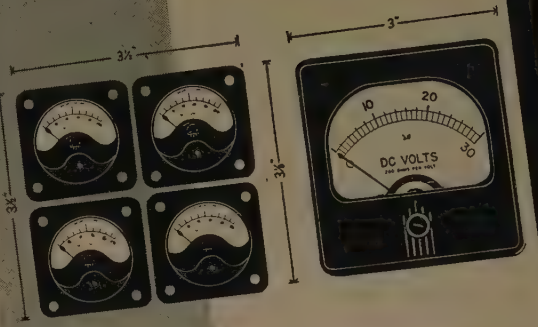
(Continued on page 44A)

DeJUR makes great little meters . . .

Panel Meters

- Miniature 1 ½" square
- Waterproof sealed
- Obtainable with Lucite scales and Magnetic Shielding

Larger sizes available
2 ½" round
2 ½" square
3 ½" round
3 ½" square
4" square
JAN-1-6 and A.S.A. specifications



Built to Conform to Forthcoming JAN Spec. for 1½" Meters

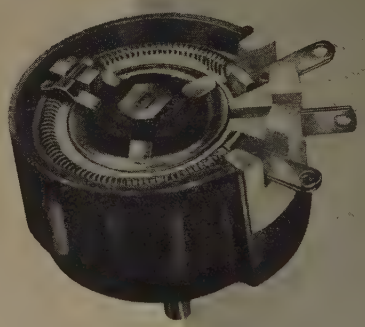
POWER Rheostats . . .

NEW ALL METAL CONSTRUCTION
with
ALUMINUM FRAME
ALUMINUM WINDING CORE
Assuring Maximum Heat Dissipation

MODEL 245 — up to 50,000 ohms (25 Watt)
MODEL 241 — up to 75,000 ohms (50 Watt)

These exceptionally high resistances are possible because of new developments in material and design. Built to JAN-R-22 Specifications.

Ceramic models available for economy and where fine precision of all metal parts is not needed.

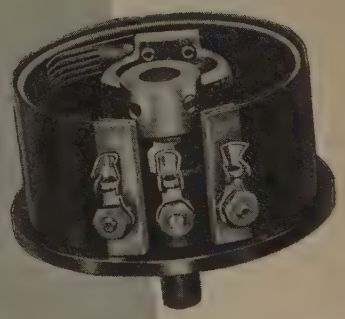


PRECISION Potentiometers

FEATURES

- Linearity Accuracy ±0.2%
- Resistance Accuracy ±1%
- High Humidity Models JAN-R-19 SPECS.
- Non-Linear Models

Send All Inquiries to Dept. E-1 for Full Information on Our Complete Line



DeJUR USA

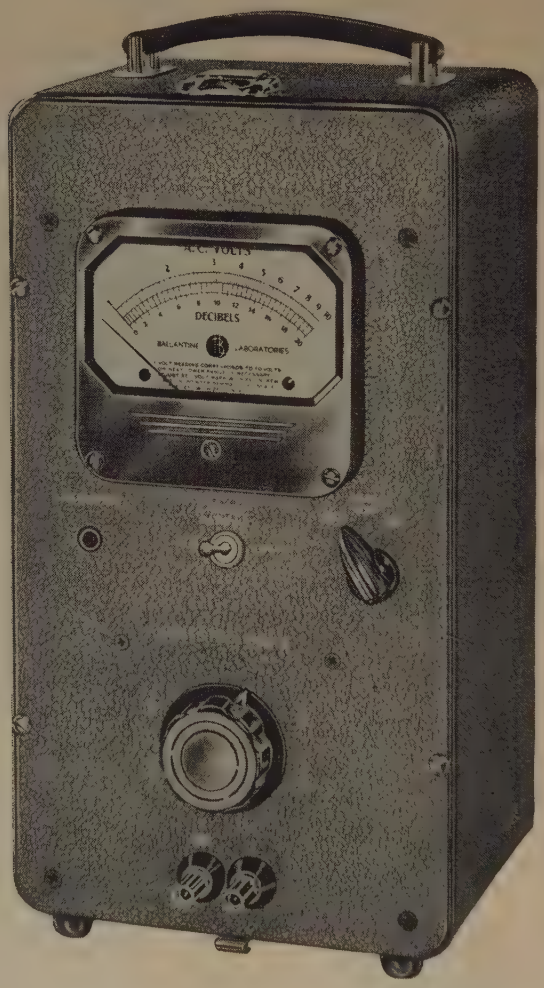
DeJUR AMSCO CORPORATION
45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.
MANUFACTURERS OF SCIENTIFIC PRECISION EQUIPMENT FOR OVER A QUARTER OF A CENTURY

Announcing...

IMPROVEMENTS IN THE

BALLANTINE BATTERY OPERATED ELECTRONIC VOLTMETER

Achieving a tenfold increase in sensitivity, higher input impedance, improved low frequency response and substantial reduction in size and weight.



VOLTAGE RANGE:
100 microvolts to 100 volts in 6 decade ranges.

INPUT IMPEDANCE:
2 megohms shunted by 8 mmfd on high ranges and 15 mmfd on low ranges.

FREQUENCY RANGE:
2 cycles to 150,000 cycles.

ACCURACY:
3%, except 5% below 5 cycles and above 100,000 cycles.

- Available multipliers increase the voltage range to 1,000 or 10,000 volts.
- Available precision shunt resistors permit the measurement of AC currents from 1 ampere down to one-tenth of a microampere.
- Features the well-known Ballantine logarithmic voltage and uniform DB scales.
- Battery life over 100 hours.
- Can also be used as a flat pre-amplifier with a maximum gain of 60 DB. Because of the complete absence of AC hum, the amplifier section will be found extremely useful for improving the sensitivity of oscilloscopes.

MODEL 302B
Size: 6⅞" x 7½" x 12⅜".
Weight: 14 lbs.
Price complete with cover and batteries: $215.

For further information on this Voltmeter and the Ballantine Model 300 Voltmeter, Wide-Band Voltmeters, Peak to Peak Voltmeters and accessories such as Decade Amplifiers, Multipliers, and Precision Shunt Resistors, write for catalog.

BALLANTINE LABORATORIES, INC.

102 Fanny Road, Boonton, New Jersey

SECTION MEETINGS

(Continued from page 42A)

HAMILTON

"Practical Design Considerations in Synch and Sweep Circuits," by N. S. Kornetz, Westinghouse Electric Corporation; September 18, 1950.

"Mission, Organization and Function of RCAF Telecommunications," by E. A. D. Hutton, Royal Canadian Air Force; October 16, 1950.

LANCASTER

"Magnetic Tape Recording Principles," by R. H. Ranger, Ranger Tone Corporation; October 11, 1950.

MONMOUTH

"The Engineer's Approach to the Human Mechanism," by J. R. Ragazzini, Faculty, Columbia University; September 27, 1950.

NORTHERN NEW JERSEY

"Color Television," by A. G. Jensen, Bell Telephone Laboratories; September 13, 1950.

"A 20 Cycle to 50 Megacycle Signal Generator," by J. M. van Beuren, Measurements Corporation; "Notes on Measurement of Phase Distortion," by D. M. Hill, Boonton Radio Corporation; "Recent Developments in Cathode-Ray Oscillography," by P. S. Christaldi, Allen B. Dumont Laboratories, Inc.; October 11, 1950.

STUDENT BRANCH MEETINGS

UNIVERSITY OF ARKANSAS, IRE BRANCH

Election of Officers; September 27, 1950.

"Geiger Counters," by Paul Damon, Faculty, University of Arkansas; October 11, 1950.

BUCKNELL UNIVERSITY, IRE-AIEE BRANCH

"Structure and Functions of the IRE," by B. H. Bueffel, Jr., Faculty, Bucknell University; "Piezo-electric Crystals," by E. J. Prokop, Student, Bucknell University; September 28, 1950.

UNIVERSITY OF CALIFORNIA, IRE-AIEE BRANCH

"The Amazing Universe," by L. E. Reukema, Faculty, University of California; September 21, 1950.

"Opportunities in Professional Societies," by J. R. Whinnery and J. Fahey, Faculty, University of California; October 10, 1950.

CARNEGIE INSTITUTE OF TECHNOLOGY, IRE-AIEE BRANCH

"Qualities I Look for in Employing Engineers," by Edward Beck, Westinghouse Corporation; September 28, 1950.

"The Present Status of Color Television," by J. T. Holland, Jr., Student, Carnegie Institute of Technology; October 3, 1950.

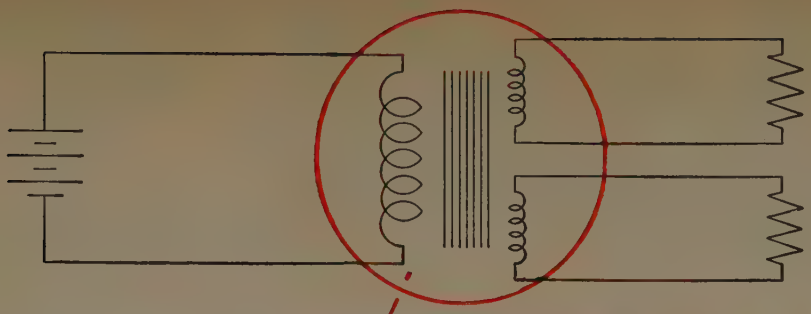
"Electrical Engineering as a Profession," by B. R. Teare, Faculty, Carnegie Institute of Technology; October 10, 1950.

CLARKSON COLLEGE, IRE BRANCH

"Advantages of The Institute of Radio Engineers," by F. A. Record, Faculty, Clarkson College of Technology; October 5, 1950.

Films; "Unseen Worlds," and "Radio at War"; October 19, 1950.

(Continued on page 46A)



a DC transformer?

Certainly...

Bendix Specialized Dynamotors are made for the Job!

Whenever DC power is required at other than the supply voltage, Bendix* Specialized Dynamotors function as DC transformers. They can be wound for any input or output voltage between 5 and 1200 volts, and they can deliver power up to 500 watts. Multiple outputs can be supplied to correspond with several secondaries on transformers, and their output voltages can be regulated within close limits regardless of input voltage or load variations. Bendix Specialized Dynamotors are tailored to the exact requirements of each application by the design of the windings used in standardized frames. This reduces the cost, size and weight to an absolute minimum, consistent with the operational requirements. Compliance with Government specifications is assured by the choice and treatment of materials and the basic design. *A complete description of your requirements will enable our engineers to make concrete recommendations . . . All orders are filled promptly and at moderate cost.*

*REG. U. S. PAT. OFF.

RED BANK DIVISION OF
BENDIX AVIATION CORPORATION
RED BANK, NEW JERSEY
Export Sales: Bendix International Division, 72 Fifth Avenue, N. Y. 11, N. Y.

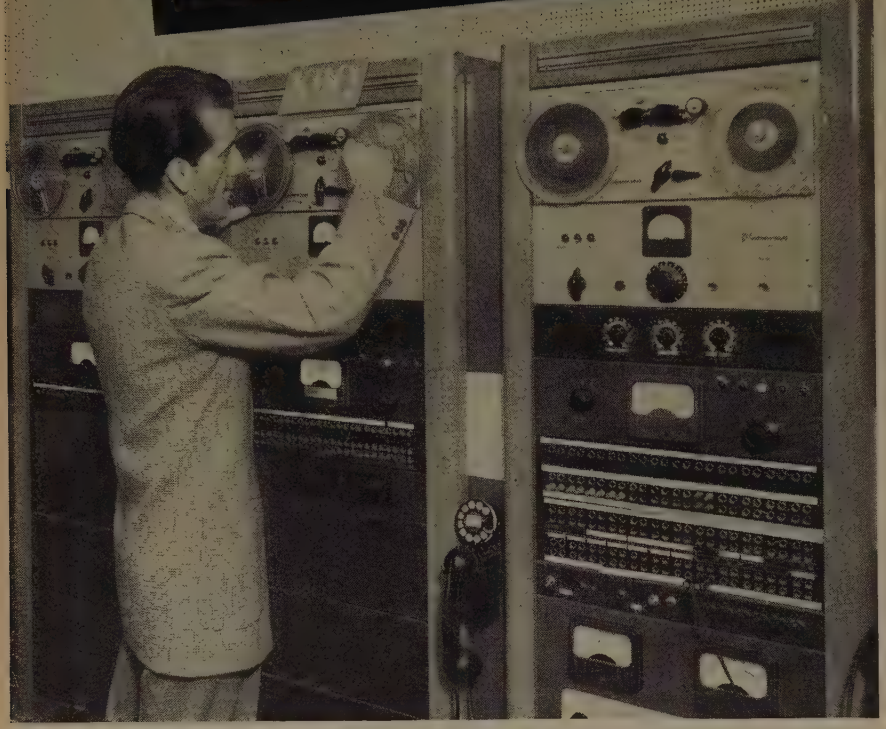
Write for this colorful and informative book —it's free. You'll find it loaded with facts and figures about all types of dynamotors.

RED BANK DIVISION

Bendix
AVIATION CORPORATION

HE CHOSE

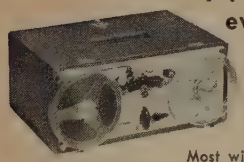
Magnecorder



THE FIRST CHOICE OF RADIO ENGINEERS

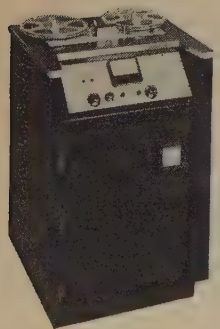
MAGNECORDER

For every purpose . . . every purse!



PT6 SERIES
Most widely used professional tape recorder in the world.

PT63 SERIES
Three heads to erase, record, and monitor from the tape.



PT7 SERIES
A complete console for only $950.00. Outstanding features and flexibility. Models for portable or rack mount also available.

More radio engineers use Magnecorders than all other professional tape recorders combined. Here's why:

HIGH FIDELITY, LOW COST

Stations are enthusiastic about the life-like tone quality and low distortion of Magnecordings. Magnecorder frequency response: 50 — 15kc ± 2 db. Signal-noise ratio: 50 db. Harmonic distortion less than 2%. Meets N.A.B. standards. No other recorder offers such fidelity at such a moderate price.

GREATEST FLEXIBILITY

Mount a Magnecorder in a rack or console cabinet for delayed studio and network shows. Slip it into its really *portable* cases for remotes. Add to your Magnecord equipment as you need it—combine Magnecorders to suit every purpose.

MORE FEATURES

Your Magnecorder, new or old, can now have 3 heads (separate erase, record, and playback) to permit monitoring from tape. Three speeds (15"—7½"—3¾" —up to an hour on a 7" reel) available on both PT6 and PT63 equipment. Dual track heads also available if desired.

Write for NEW CATALOG

MAGNECORD, INC., Dept. P12
360 North Michigan Avenue, Chicago 1, Ill.
Send me latest catalog of Magnecord Equipment.

Name.....

Company.....

Address.....

City.....Zone..... State.....

(Continued from page 44A)

UNIVERSITY OF COLORADO, IRE-AIEE BRANCH

"Introduction to the AIEE," by C. DuVall, Faculty, University of Colorado; Films; "Turbo-Jet Propulsion," and "Seeing at Home"; October 3, 1950.

UNIVERSITY OF CONNECTICUT, IRE-AIEE BRANCH

"Television," by G. W. Ray, Radio Station WNHC; October 5, 1950.

COOPER UNION, IRE BRANCH

Business Meeting; and Election of Officers; October 3, 1950.

CORNELL UNIVERSITY, IRE-AIEE BRANCH

"Progress in Better Living," by L. P. Shannon, E. I. DuPont de Nemours and Company; October 6, 1950.

UNIVERSITY OF DENVER, IRE-AIEE BRANCH

Business Meeting; October 5, 1950.

Business Meeting; Film: "Quartz Crystals"; October 17, 1950.

UNIVERSITY OF FLORIDA, IRE-AIEE BRANCH

"What You Don't Know, May Hurt You," by E. D. Whittlesey, Faculty, University of Florida; October 3, 1950.

UNIVERSITY OF KENTUCKY, IRE BRANCH

"Quality Control in Manufacturing," by C. C. Jones, General Electric Company; October 12, 1950.

LAFAYETTE COLLEGE, IRE-AIEE BRANCH

"VHF Omnidirectional Radio Range," by R. H. Wilcox, Student, Lafayette College; October 10, 1950.

MARQUETTE UNIVERSITY, IRE-AIEE BRANCH

Business Meeting; and Election of Officers; October 5, 1950.

UNIVERSITY OF MARYLAND, IRE-AIEE BRANCH

Discussion by Students; and Election of Officers; October 18, 1950.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, IRE-AIEE BRANCH

"Industrial Organization," by Mr. Powell, Faculty, Massachusetts Institute of Technology; November 7, 1949.

"Boston's New Telephone Company Building," by W. F. Potter, Bell Telephone System; November 21, 1949.

Inspection Trip of New Telephone Building; November 22, 1949.

"Electrostatic Generators in Industry," by E. A. Burrill, High Voltage Engineering Corporation; December 8, 1949.

"MIT Center of Analysis," by S. Caldwell, Faculty, Massachusetts Institute of Technology; January 16, 1950.

"Electrostatic Precipitation," by Mr. Price, Raytheon Manufacturing Company; February 20, 1950.

Slides shown by Frank Doble, Doble Engineering Company; March 13, 1950.

"Some General Considerations in Audio System Design," by John Kessler, Faculty, Massachusetts Institute of Technology Acoustics Laboratory; March 20, 1950.

"50-920 MCPS Standard Signal Generator," by Erwin Gross, General Radio Company; April 17, 1950.

"Light Magic," by L. S. Cooke, General Electric Company; Nomination of Officers; May 1, 1950.

(Continued on page 48A)

A SENSATIONALLY NEW FACE

— — — for

TELEVISION PICTURE TUBES!

WATCH FOR THE ANNOUNCEMENT OF

Sheldon's NEW LINE OF NO-GLARE, ALL-GLASS VITATRON* Picture Tubes

SHELDON ELECTRIC CO.

Division of Allied Electric Products Inc.

68-98 Coit Street, Irvington 11, N. J.

Branch Offices & Warehouses:

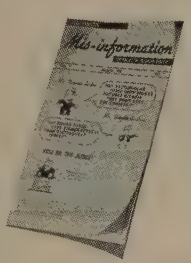
CHICAGO 7, ILL., 426 S. Clinton St.
LOS ANGELES 26, CAL., 1755 Glendale Blvd.

*TRADEMARK

TELEVISION PICTURE TUBES • CATHODE RAY TUBES • FLUORESCENT LAMP STARTERS AND LAMPHOLDERS • SHELDON REFLECTOR AND INFRA-RED LAMPS
PHOTOFLOOD AND PHOTOSPOT LAMPS • SPRING-ACTION PLUGS • TAPMASTER EXTENSION CORD SETS AND CUBE TAPS • RECTIFIER BULBS

KEEP INFORMED!

If you would like to know what is happening in the Television Industry, send for your FREE *subscription* to "TELEVISION MIS-INFORMATION" — the famous publication with over 60,000 readers in the Industry.



MAIL COUPON TODAY!

TELEVISION MIS-INFORMATION, 68 Coit St., Irvington 11, N. J.
Please enter my FREE SUBSCRIPTION to your magazine.

My Name.....

Company..... Title .....

Address to which it is to be mailed.....

4

Specify BREEZE "Monobloc" Waterproof and Pressure Sealed CONNECTORS

The only APPROVED Monobloc System for Advanced Radar, Communications, and Electronic Equipment

Breeze "Monoblocs", with single piece plastic inserts, offer outstanding advantages in assembly, wiring, mounting and service in the field.

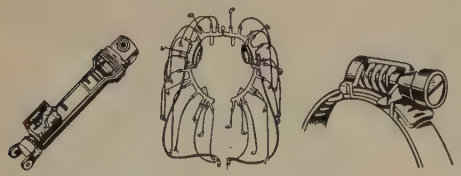
Single piece inserts make a tighter unit, eliminate the air spaces within conventional multiple-piece inserts, greatly reduce the opportunity for moisture shorts.

Removable contact pins make possible bench soldering of leads, quick, error free assembly of Breeze Waterproof Connectors and panel-type "Monobloc Miniatures."

Single-Hole Panel Mounting is all that is required for either Waterproof or Pressure Sealed types.

Pressure Sealed types are available for values up to and including 75 psi, or they can be specially engineered for greater pressures. They meet specified requirements of shock, vibration, salt spray, humidity and temperature cycling from −65° to +185° F.

Breeze "Monobloc" Waterproof and Pressure Sealed Connectors are engineered to your requirements in aluminum, brass or steel —in all sizes and capacities. They are fully tested and approved... cost no more than ordinary types.



Write for Details

If you have a tough connector problem, ask BREEZE for the answer!

Other Breeze Precision Products

ACTUATORS: All types, sizes. Complete control systems engineered to requirements. Above: Landing gear actuator Fairchild Packet.

RADIO SHIELDING: For any type of high or low tension system. New type "unit leads" or re-wirable leads. Flexible shielded conduit.

"AERO-SEAL" Worm-Drive Hose Clamps. Vibration proof, uniform clamping, use again and again. All clamps have stainless steel bands.

BREEZE

CORPORATIONS, INC.

41-G South Sixth Street, Newark 7, N.J.

(Continued from page 46A)

Election of Officers; September 27, 1950.

"Personnel and Organization of Radio and Television Stations," by S. V. Stadig, Radio Station WBZ-TV; October 9, 1950.

UNIVERSITY OF MICHIGAN, IRE-AIEE BRANCH

"The Engineer in the Field of Management," by P. W. Thompson, Detroit Edison Company; October 3, 1950.

MISSOURI SCHOOL OF MINES & METALLURGY, IRE-AIEE BRANCH

"Engineering Contributions to the Medical Sciences," by J. T. Wilson, Allis-Chalmers Company; September 28, 1950.

"Recent Developments in Missouri's Electric Utilities," by James Stephen, Missouri Public Service Corporation; October 12, 1950.

NEW MEXICO COLLEGE OF AGRICULTURE & MECHANIC ARTS, IRE-AIEE BRANCH

"The Aerobee Rocket," by G. H. Fesselman, Physical Science Laboratory; September 21, 1950.

COLLEGE OF THE CITY OF NEW YORK, IRE BRANCH

Business Meeting; Film: "Rotating Magnetic Fields"; September 28, 1950.

"Power Generation and Transmission," by Harold Baumann, Consolidated Edison Company; October 5, 1950.

NEW YORK UNIVERSITY, IRE BRANCH (DAY DIVISION)

"Analog Computers," by Milton Gerber, Reeves Instrument Company; June 7, 1950.

"Japanese Engineering Education," by Professors Cato, Watanabe, and Asami; September 28, 1950.

Business Meeting; October 5, 1950.

"Jobs Available to Young Engineering Graduates," by W. G. Denning, Consolidated Edison Company; October 19, 1950.

NORTHEASTERN UNIVERSITY, IRE-AIEE BRANCH

"Lightning," by C. L. Dawes, Faculty, Harvard University; September 21, 1950.

Field Trip to Radio Station WBZ-TV; September 26, 1950.

Films: "Where Shall You Hide," "One World or None," and "Atomic Energy"; October 3, 1950.

OHIO STATE UNIVERSITY, IRE-AIEE BRANCH

"Experiences of a Campus Publication Advisor," by W. R. Dumble, Faculty, Ohio State University; October 12, 1950.

OREGON STATE COLLEGE, IRE BRANCH

"The IRE and AIEE and Student Engineers," by F. O. McMillan, Faculty, Oregon State College; September 28, 1950.

"Vibration in Transmission Line Conductors," by R. F. Steidel, Faculty, Oregon State College; October 12, 1950.

PENNSYLVANIA STATE COLLEGE, IRE-AIEE BRANCH

Introduction of Officers; September 21, 1950.

PRATT INSTITUTE, IRE BRANCH

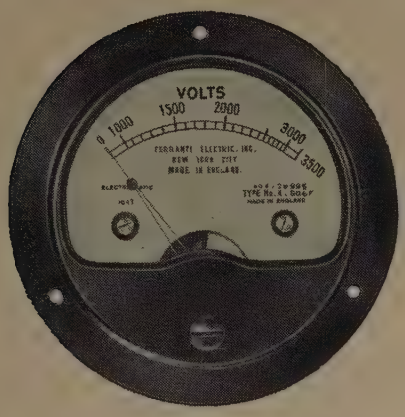
"Distribution Engineering," by Charles Metcalfe, Consolidated Edison Company; October 11, 1950.

RENSSELAER POLYTECHNIC INSTITUTE, IRE-AIEE BRANCH

"Advantage of a Professional Society—Job Interviews," by E. S. Lee, General Electric Consulting Laboratory; October 18, 1950.

(Continued on page 49A)

A TRUE ELECTROSTATIC VOLTMETER



This instrument permits voltage readings on AC or DC circuits of very high resistance. The only current drawn is the very small leakage current and a very low capacitance current on AC circuits. Very useful for the many high voltage—low current circuits employed in nuclear research. Available with full scale voltages ranging between 300 and 3500 volts. Special laboratory instrument available with full scale reading of 150 volts. Full scale capacitance ranges from 8 mmfds for the 3500 volt model to 100 mmfds for the 150 volt instrument. Magnetic damping. 2½" dial. Write for complete specifications.

FERRANTI

FERRANTI ELECTRIC, INC.
30 Rockefeller Plaza • New York 20, N. Y.
FERRANTI, LTD., Hollinwood, England
FERRANTI ELECTRIC, LTD., Toronto, Canada

Student Branch Meetings

(Continued from page 48A)

RHODE ISLAND STATE COLLEGE, IRE-AIEE BRANCH

Business Meeting; September 26, 1950.

"Implications of New FCC Ruling for Color Television," by W. B. Hall, Faculty, Rhode Island State College; October 19, 1950.

RUTGERS UNIVERSITY, IRE-AIEE BRANCH

Film: "Adventures in Research"; October 10, 1950.

UNIVERSITY OF SOUTHERN CALIFORNIA, IRE-AIEE BRANCH

Business Meeting; "The Preparation and Presentation of Student Papers," by R. M. Strassner; September 28, 1950.

SYRACUSE UNIVERSITY, IRE-AIEE BRANCH

Election of Officers; Film: "1949 Syracuse-Colgate Football Game"; September 28, 1950.

UNIVERSITY OF TEXAS, IRE-AIEE BRANCH

"Zurich Radio Conference," by A. W. Straiton, Faculty, University of Texas; October 16, 1950.

TUFTS COLLEGE, IRE-AIEE BRANCH

"Professional Societies," by A. H. Howell, Faculty, Tufts College; October 4, 1950.

UNIVERSITY OF WYOMING, IRE-AIEE BRANCH

"Organization, Purpose and Aims of AIEE," by W. C. DuVall; October 5, 1950.

The following transfers and admissions were approved and will be effective as of December 1, 1950:

Transfer to Senior Member

Beusman, R. M., 1212 Woodbine Ave., Oak Park, Ill.
Capodanno, R. T., 50 Coolidge Ave., W. Caldwell, N. J.
Chapman, J. K., 329 Westvale Rd., Syracuse 9, N. Y.
Farr, K. E., R. D. 1, Box 193A, Paxinos, Pa.
Forster, W. H., 920 E. Mt. Airy Ave., Philadelphia 19, Pa.
Hansen, W. W., 8819 S. Talman Ave., Chicago 42, Ill.
Hargens, C. W., III, 909 Hunters Lane, Enfield, Oreland P. O., Pa.
Henderson, A. B., 801 Hathaway Rd., Dayton 9, Ohio
Horvath, A., 212 Harding Ave., Clifton, N. J.
Ittelson, R. W., 551 Daytona Pkwy., Dayton 6, Ohio
Keachie, J. H., RCA Victor Division, 718 Keith Bldg., Cleveland 15, Ohio
McClellan, C. E., 1306 Tarrant Rd., Glen Burnie, Md.
Murphy, J. L., 1456 E. 54 St., Chicago 15, Ill.
Rambo, S. I., 154 Oaklee Village, Baltimore 29, Md.
Reid, J. G., Jr., 2929 Connecticut Ave., N.W., Washington, D. C.
Ritter, E. H., Northrop Aircraft, Inc., Hawthorne, Calif.
Senn, G. F., 81 Garden Rd., Little Silver, N. J.
Stoker, W. C., Brunswick Rd., Rt. 57, Troy, N. Y.
Swanson, M. W., 8704 Maywood Ave., Rosemary Hills, Silver Springs, Md.

(Continued on page 62A)

P D Q!

Shown; Bliley Type MC-9

Production... Delivery . . . Quality!

Three qualifications are needed to assure performance on your orders. PRODUCTION facilities . . . keyed to your DELIVERY dates . . . plus rigid QUALITY control. These factors are *basic with Bliley* . . . top choice for 20 years.

Bliley CRYSTALS

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING
ERIE, PENNSYLVANIA

Engineers

Physicists

Expansion of the permanent staff of the Boeing Airplane Company's Physical Research Unit has created openings for research and development on

Electronic and microwave circuits
Flush antennas
Servomechanisms and computers
Radar systems and components
Instruments and gyros

Men are need who have demonstrated outstanding experimental or analytical ability or who have recently received the MS or PhD degree with high honors in EE, Physics or Applied Mathematics.

These positions offer challenging work in a professional environment plus the unparalled recreational possibilities of the Pacific Northwest.

Opportunity for advancement is essentially unlimited in the rapidly expanding fields of guided missiles, airplane control and industrial machine and process control. Salaries are based on semi-annual performance reviews.

—Address inquiries to—

MR. JOHN C. SANDERS
Staff Engineer—Personnel
Boeing Airplane Company
Seattle 14, Washington

POSITIONS OPEN

The following positions of interest to I.R.E. members have been reported as open. Apply in writing, addressing reply to company mentioned or to Box No. ...

The Institute reserves the right to refuse any announcement without giving a reason for the refusal.

PROCEEDINGS of the I.R.E.
1 East 79th St., New York 21, N.Y.

PROJECT ENGINEERS

Five years or more experience in charge of design and development of radio and communication equipment. Must be graduate of a credited engineering school. Well equipped laboratory in modern radio and television plant, with excellent opportunities for advancement. Send resume of qualifications to Mr. S. F. Cascio, Personnel Director, Hallicrafters Co., 4401 West Fifth Ave., Chicago 24, Ill.

ENGINEERS

A very large vacuum tube and cathode ray tube manufacturer has attractive openings for experienced vacuum tube engineers. It will be to your benefit to investigate these possibilities. Please write to Box 628.

SENIOR ELECTRONIC ENGINEER

Opportunity with manufacturer of electronic electro-mechanical and radiation instruments. Requirements: 5 years experience in design and development of pulse circuits, computers, nuclear instrumentation or video circuits required. Manufacturing or production experience desirable. Send complete resumes and salary requirement to: Berkeley Scientific Company, P.O. Box 1826, Richmond, Calif.

PRODUCTION ENGINEER

Opportunity with manufacturer of electronic, electro-mechanical and radiation instruments. Requirements: 5-10 years experience as electronic and mechanical instrument production engineer in small lot production. Thorough electronic theory grounding. Send complete resume and salary requirements to Berkeley Scientific Co., P.O. Box 1826, Richmond, Calif.

ELECTRICAL ENGINEER

Graduate with experience in design and product technique of specialized electronic tubes other than high production transmitting and receiving types. Bendix Aviation Corp., Kansas City Division, P.O. Box 1159, Kansas City, Missouri.

ELECTRONIC ENGINEER

Excellent opportunities are offered by one of the leading concerns in the electronic computer field to engineers with development or design experience in video and pulse circuitry or test and maintenance experience in the radar television or computer fields. Send complete information to Personnel Dept., Eckert-Mauchly Computer fields. Send complete information to 32, Pa.

ELECTRONIC ENGINEERS

Electronic engineers with a background in patent specification writing desired for an expanding Patent Dept. in a growing

(Continued on page 51A)

ELECTRONICS TECHNICIANS WANTED

The RCA Service Company, Inc., a Radio Corporation of America subsidiary, needs qualified electronics technicians for U. S. and overseas assignments. Candidates must be of good character and qualified in the installation or maintenance of RADAR or COMMUNICATIONS equipment or TELEVISION receivers. No age limits, but must have at least three years of practical experience.

RCA Service Company offers comprehensive Company-paid hospitalization, accident and life insurance programs; paid vacations and holidays; periodic review for salary increases; and opportunity to obtain permanent position in our national and international service organization, engaged in the installation and maintenance of AM, FM, and TV transmitters, electronic inspection devices, electron microscopes, theatre and home television, r-f heating equipment, mobile and microwave communications systems, and similar electronic equipment.

Base pay, overseas bonus, payments for actual living and other expenses, and benefits mentioned above add up to $7,000 per year to start for overseas assignments, with periodic review of base salary thereafter. Openings also available at proportionately higher salaries for specially qualified technicians with supervisory ability.

Qualified technicians seeking an advantageous connection with a well-established company, having a broad-based, permanent peacetime and wartime service program, write to:

Mr. G. H. Metz,
Personnel Manager,
RCA Service Company, Inc.,
Camden 2, New Jersey.

POSITIONS OPEN

(Continued from page 50A)

research and development organization located in the midwest. Unlimited opportunity for advancement for properly qualified men. Law degree unnecessary. Must be U. S. citizen and free to make occassional trips to Washington D. C. Please give full details in first letter. Box 630.

ELECTRONIC ENGINEER

Senior graduate engineer with at least 10 years experience in receiver design. Minimum of 2 years experience UHF desirable. Must be capable of assuming project responsibility. Location Connecticut. Excellent opportunity. Salary high Submit resume. Box 631.

ELECTRONIC ENGINEERS

The U. S. Naval Ordnance Experimental Unit is located at the National Bureau of Standards, Washington, D.C. The following vacancies exist in grades GS 14, $8800, GS 13, $7600 and others of Electronic Engineers (General) (Radar) (Instrumentation) and (Stabilization). Assignments will include consultation, evaluation and product engineering in the development of guided missile components. Enclose copy of Civil Service Application Form 57 (obtainable at local post office) and address completed form to Officer in Charge, U. S. Naval Ordnance Experimental Unit, National Bureau of Standards, Washington 25, D.C.

ELECTRONIC ENGINEER

Electronic engineer with interest in instrumentation and automatic control to join instrument development group at the Wind Tunnels Laboratory. Starting salary $3100-$3825 per annum. Apply Civilian Personnel Division, Aberdeen Proving Ground, Maryland.

ENGINEER

Small California transmitting tube company requires engineer for medium frequency tube work, also for development and manufacture of klystrons and pulse tubes. Give full details giving age, experience, availability and salary expected. Box 632.

ENGINEERS AND PHYSICISTS

Project and senior engineers desired for work on several theoretical and experimental programs of diversified nature involving military applications of electronics. Applicants should have 3 or more years of experience in research and development in some branch of electronics and preferably advanced graduate training. Command of physical fundamentals and analytical ability important. Small, expanding company located in college town. Opportunities of graduate study. Reply Personnel Manager, Haller, Raymond and Brown, Inc. State College, Pa., stating education, experience, salary expected.

ENGINEERS

National Broadcasting Company needs experienced engineers with commercial television operating experience or standard broadcasting control room experience. Apply Room 505, 30 Rockefeller Plaza, New York, N.Y.

(Continued on page 52A)

The W. L. MAXSON CORPORATION IS SEEKING

Outstanding ENGINEERS AND PHYSICISTS with AMBITION TO FURTHER PRESENT STANDING *Immediately*

Minimum Requirements are:

1. Five to ten years experience in advanced electronic research and development
2. Outstanding record of ingenuity
3. Ph.D., M.S. or equivalent

Please send résumé and salary requirements to:

The W. L. MAXSON CORPORATION
460 W. 34th St.
New York 1, N.Y.

ELECTRICAL ENGINEERS

•

Independent industrial research and development laboratory has openings for electrical engineers with training and experience in the following fields; UHF; Instrumentation; Telemetering; Computers; Servo and Control Systems; and Electromagnetic Devices.

Candidates should have an excellent scholastic record. Advanced degree helpful, but not essential. Requires 2-5 years experience, with record of accomplishment in one or more of the above fields.

Good salaries for outstanding men plus other benefits—such as a retirement plan (immediate vesting), group insurance, and nearby opportunities for graduate work. Excellent opportunities for advancement.

Write, giving survey of qualifications, to

Electrical Engineering Research
ARMOUR RESEARCH FOUNDATION of
ILLINOIS INSTITUTE OF TECHNOLOGY
Technology Center
Chicago 16, Illinois

PHYSICISTS, ENGINEERS APPLIED MATHEMATICIANS

Electronic and mechanical engineers, physicists and applied mathematicians.

POSITIONS AVAILABLE AT ALL LEVELS

for research and development in radar, microwaves, servo systems, computers, telemetering, instrumentation and nucleonics.

Permanent positions offering variety, responsibility, and challenging opportunities for advancement.

BENDIX AVIATION CORPORATION
RESEARCH LABORATORIES
4855 Fourth Avenue
Detroit 1, Michigan

POSITIONS OPEN

(Continued from page 51A)

ELECTRON TUBE ENGINEERS

For development and production. Experience miniature or sub-miniature tubes desirable. Apply by letter only to Personnel Dept., Sonotone Corp., Elmsford, New York.

RADIO AND TELEVISION ENGINEERS

Experienced in design of high frequency circuits such as FM tuners, TV boosters and TV antennae. Salary commensurate with ability. Write giving full details—Mr. Stone, Talk-A-Phone Company, 1512 South Pulaski Rd., Chicago 23, Ill. Lawndale 1-8414.

ENGINEERS

Physicists, chemists or EE's with PhD or equivalent and experience in the field of solid state physics for research work on semi-conductor devices employing germanium and silicon. An excellent opportunity in a research laboratory of a leading manufacturer with laboratories in New York state. Send complete resume. Our employees have been notified. Box 633.

SENIOR ELECTRONICS ENGINEER

For design and development of circuitry for ultrasonic equipment timing circuits, audio oscillators amplifiers, and audio measuring equipment to meet Navy specifications. Experience required: 3-5 years in development of audio or supersonic equipment for government or industrial usage. Must have B.S. in physics or electrical engineering. Write: Personnel Director, Box 30, State College, Pa.

DEVELOPMENT TECHNICIANS

At least 3 years experience in layout. (Including rough drafting) of electronic chassis. Should also be experienced in electronics testing and trouble shooting. Write: Personnel Director, Box 30, State College, Pa.

ELECTRICAL ENGINEER

Graduate electrical engineer with a minimum of 2 years' experience. For design and development of audio transformers and filters. Permanent position with progressive firm located in Chicago. Give details stating age, education, experience, references, availability for work and salary expected. Box 634.

ENGINEERS

The 15th Naval District which comprises the Panama Canal Zone is in need of electronic engineers, electronics draftsmen, radio and electronic mechanics. Employment is with the Navy. No Civil Service status is required for these positions in Canal Zone. Rates pay as follows: Engineers—$5750-$6650. Draftsmen—$4300-$5250. Mechanics—$2.02-$2.23 per hour. Employment under an 18 month agreement which provides transportation with shipment of household effects to and from the home of employee and is subject to indefinite renewal. Apply: Commandant, 15th Naval Dist. (District Civilian Personnel Office) Box 127, Fort Amador, Canal Zone.

ELECTRONIC SCIENTIST

For research in upper atmosphere rocket program. Must have an appropriate de-

(Continued on page 54A)

Graduate
ENGINEERS

Good Opportunities *for* ELECTRONICS

Engineers or Physicists

M.S. or Ph.D. in Physics, Physical Chemistry, E.E., M.E., or Ch.E. for industrial electronics research. Must be outstanding technically with at least a few years research experience, and interested in the development of instruments and physical techniques.

Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific.

All inquiries will be considered promptly and kept confidential.

E. I. du Pont de Nemours & Co. (Inc.)
Engineering Department Personnel
Wilmington 98, Delaware

RESEARCH ENGINEERS ELECTRICAL ENGINEERS AND PHYSICISTS

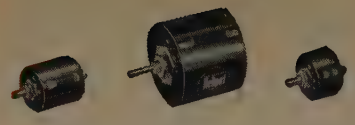
THE FRANKLIN INSTITUTE LABORATORIES FOR RESEARCH AND DEVELOPMENT

Have opening for personnel with 2-10 years experience. Advanced degrees are desirable in certain of the positions. Fields of interest covered are: Mathematical Analysis of Physical Problems, Statistical Theory of Communications, Electromagnetic Theory, Circuit Analysis, Servomechanism Theory, Electrical Computing, Advanced and Fundamental Circuit Development, Radar and Pulse Circuits, Supervision of Operation of G.C.A. or Tracking Radar, Air Traffic Control, Air Navigation, Automatic Controls, Industrial or Marine Power Drives, and Electrical Machinery.

Send resume of education and experience, salary requirements and a photograph to:

Personnel Department
THE FRANKLIN INSTITUTE
Philadelphia 3, Pennsylvania

In this panel are illustrated standard models of HELIPOT multi-turn and single-turn precision potentiometers—available in a wide range of resistances and accuracies to fulfill the needs of nearly any potentiometer application. The Beckman DUODIAL is furnished in two designs and four turns-ratios, to add to the usefulness of the HELIPOT by permitting easy and rapid reading or adjustment.



A B C

MODELS A, B, & C HELIPOTS
A—10 turns, 46" coil, 1-13/16" dia., 5 watts—resistances from 10 to 300,000 ohms.
B—15 turns, 140" coil, 3-5/16" dia., 10 watts—resistances from 50 to 500,000 ohms.
C—3 turns, 13-1/2" coil, 1-13/16" dia., 3 watts—resistances from 5 to 50,000 ohms.

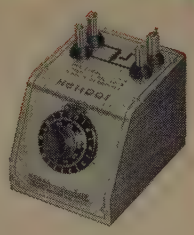
D E

MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234" coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373" coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.

F G

MODELS F AND G PRECISION SINGLE-TURN POTENTIOMETERS
Feature both continuous and limited mechanical rotation, with maximum effective electrical rotation. Versatility of designs permit a wide variety of special features.
F—3-5/16" dia., 5 watts, electrical rotation 359°—resistances 10 to 100,000 ohms.
G—1-5/16" dia., 2 watts, electrical rotation 356°—resistances 5 to 20,000 ohms.

LABORATORY MODEL HELIPOT
The ideal resistance unit for use in laboratory and experimental applications. Also helpful in calibrating and checking test equipment. Combines high accuracy and wide range of 10-turn HELIPOT with precision adjustability of DUODIAL. Available in eight stock resistance values from 100 to 100,000 ohms, and other values on special order.



R W

MODELS R AND W DUODIALS
Each model available in standard turns-ratios of 10, 15, 25 and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.
R—2" diameter, exclusive of index.
W—4-3/4" diameter, exclusive of index. Features finger hole in knob to speed rotation.

FOR PRECISION POTENTIOMETERS come to Helipot

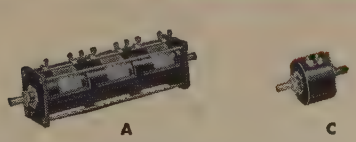
For many years The HELIPOT Corporation has been a leader in the development of advanced types of potentiometers. It pioneered the *helical* potentiometer—the potentiometer now so widely used in computer circuits, radar equipment, aviation devices and other military and industrial applications. It pioneered the DUODIAL*—the turns-indicating dial that greatly simplifies the control of multiple-turn potentiometers and other similar devices. And it has also pioneered in the development of many other unique potentiometric advancements where highest skill coupled with ability to mass-produce to close tolerances have been imperative.

In order to meet rigid government specifications on these developments—and at the same time produce them economically—HELIPOT* has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001" diameter. These winding machines are further supplemented by special testing facilities and potentiometer "know-how" unsurpassed in the industry.

So if you have a problem requiring *precision potentiometers* your best bet is to bring it to The HELIPOT Corporation. A call or letter outlining your problem will receive immediate attention!

Trade Marks Registered

The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, high and low temperature operation, and close tolerances on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.



A C

3-GANGED MODEL A HELIPOT AND DOUBLE SHAFT MODEL C HELIPOT
All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment.
The Model F, and the A, B, and C HELIPOTS are available in multiple assemblies, ganged at the factory on common shafts, for the control of associated circuits.

B F

MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 40 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 19 additional taps on the middle two sections. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

THE Helipot CORPORATION, SOUTH PASADENA 6, CALIFORNIA

POSITIONS OPEN IN RESEARCH AND ADVANCED DEVELOPMENT PROGRAMS

TO

Research Physicists

Senior Electronic Engineers

Senior Mechanical Engineers

Engineering Physicists

Circuit Engineers

Microwave Engineers

Vacuum Tube Research Engineers

Technical Report Writers

Electronic Technicians

Experienced or Holding Advanced Degrees For Research, Design, or Development In

Radar, Servomechanisms, Computers, Receivers, Photo Emission, Secondary Emission, Converters, Pulse and Timing Techniques, Special Test Equipment, Special Purpose Tubes, Circuit Design, Solid State Physics, Light and Electron Optics, etc.

We invite interested personnel with experience in the above fields to submit a complete and detailed resume of education and experience, together with salary requirements and availability date, to:

The Employment Department
CAPEHART-FARNSWORTH CORPORATION
Fort Wayne 1, Indiana

(Continued from page 52A)

gree, and at least 3 years experience, with emphasis on electronics as applied to upper atmosphere research or an allied field. Please address replies, containing a brief resume of experience to Employment Officer, Naval Research Laboratory, Washington 25, D.C.

RADIO & RADAR ENGINEERS

Radio and radar engineers for aircraft installation and application design work. Should have 5 or more years' experience with aircraft radio or radar systems, and preferably have aircraft installation or antenna design, selection and application experience. Experienced aircraft electrical engineers are also needed. Contact Engineering Personnel Section, Chance Vought Aircraft, P.O. Box 5907, Dallas, Texas.

ELECTRONIC ENGINEER

Electronic engineer to head engineering department. Must have had experience in development and design of quartz crystals for frequency control and thorough knowledge of manufacturing processes. Box 636.

★ ★ ★ ★

Positions Wanted By Armed Forces Veterans

In order to give a reasonably equal opportunity to all applicants, and to avoid overcrowding of the corresponding column, the following rules have been adopted:

The Institute publishes free of charge notices of positions wanted by I.R.E. members who are now in the Service or have received an honorable discharge. Such notices should not have more than five lines. They may be inserted only after a lapse of one month or more following a previous insertion and the maximum number of insertions is three per year. The Institute necessarily reserves the right to decline any announcement without assignment of reason.

COMMUNICATIONS ENGINEER

B.S.E.E. September 1950, Ohio State University. Married, age 25. 6 years AM and FM broadcasting experience. Chief Engineer overseas Armed Forces radio station 8 months. 1st class radio-telephone license. Desires production or design. Box 476 W.

ELECTRICAL ENGINEER

B.S.E.E. Kansas State College, January 1950. Eta Kappa Nu, I.R.E. Age 29, married. Aircraft electrician, Army radar. Interested in sales, design or development of electronic equipment. Location and salary secondary. Box 478 W.

(Continued on page 55A)

TOP TELEVISION COMMUNICATIONS and RADIO MFR.

Needs Help

to meet our expanding civilian business and increasing military contracts.

•

Good opportunity for Electrical and Mechanical Exp. Engineers. Lab. Technicians and Draftsmen

. . . to improve their status, job security and working conditions.

Apply by letter only stating experience, schooling, age, salary and reason for change.

Our employees know about this ad.

Chicago location.

•

Address Box 641
The Institute of Radio Engineers
1 East 79th St., New York 21, N.Y.

COIL ENGINEER

Large manufacturer of radio and television receivers has an opening for an experienced coil engineer to design RF and IF coils for mass production.

Should have a thorough background in coil application and coil manufacturing techniques. Send complete resume giving education, experience, age, and salary requirements.

Box No. 637
THE INSTITUTE OF RADIO ENGINEERS
1 East 79th St., New York 21, N.Y.

Positions Wanted

(Continued from page 54A)

ELECTRONICS INSTRUCTOR

Nine years servicing civilian and government RXs, and TXs and PA systems; 6 years teaching AM, FM and TV mathematics, theory and laboratory; 2 years Navy radar training. Last positions: organized school technically and held chief instructors status 3 years. Box 479 W.

ELECTRONIC ENGINEER—PHYSICIST

Six years of physics, electrical engineering and electronics in Fordham, University of Rochester, Harvard, Massachusetts Institute of Technology and Brooklyn Polytechnical Institute: B. S. in Physics, June 1949. 1½ years servomechanism development plus 3 years as Naval electronics officer. Age 27, married, 2 children. Desires position in electrical engineering, technical or sales anywhere in U. S. or overseas. Box 480 W.

ELECTRICAL ENGINEER

Recent electrical engineering graduate. Some experience. Special interest in design of VHF communications equipment, propagation studies or field surveys, and evaluation of overall system performance. Desires position continental U.S.A. Box 481W.

ELECTRONIC ENGINEER

B.E.E. June 1949, University of Delaware, Age 25, married. 3½ years Navy AETM. 1 year in nucleonic instrument maintenance, calibration, and modification. Desires research or development position in New York or Philadelphia area. Box 482 W.

(Continued on page 58A)

RESEARCH ENGINEERS

CALIFORNIA INSTITUTE OF TECHNOLOGY JET PROPULSION LABORATORY, PASADENA CALIFORNIA

Needs Research Engineers for work on their Missile Program in the following electronic categories:

RADAR
ANTENNAS
TELEMETERING
COMPUTERS
INSTRUMENTATION
ANALOG COMPUTERS

Apply in writing and furnish information as to education and experience. 4800 Oak Grove Drive, Pasadena 3, California.

TECHNICAL EDITORS AND WRITERS

These are senior positions, the men selected must be able to outline, compile, edit, proofread, plan and check art, dummy, and direct the final publication of technical and scientific publications.

A good working knowledge of radio and radar theory and application is essential, in addition to extensive editorial and journalistic experience. Some knowledge of structural and mechanical engineering is desirable.

Send complete resume with first letter to:

James E. Thompson
Department 29
HUGHES AIRCRAFT COMPANY
Culver City, California

All replies will be handled in the strictest confidence

SCIENTISTS AND ENGINEERS

for

challenging research and advanced development in fields of

RADAR
GYROSCOPES
SERVOMECHANISMS
MECHANICAL SYSTEMS
ELECTRONICS CIRCUITS
APPLIED PHYSICS AND MATH
PRECISION MECHANICAL DEVICES
ELECTRICAL SYSTEM DESIGN
GENERAL ELECTRONICS
INSTRUMENTATION
MICROWAVES
COMPUTERS
AUTOPILOTS

Scientific or engineering degree and extensive technical experience required.

WRITE:
Manager, ENGINEERING PERSONNEL
BELL AIRCRAFT CORPORATION
P.O. Box 1, Buffalo 5, N.Y.

PHYSICISTS AND ENGINEERS

You can find plenty of positions where you will work on minor improvements on radar, telemetering systems, and other conventional devices. However, you will find very few positions where you can break ground in new fields having tremendous significance. This you can do at the JACOBS INSTRUMENT COMPANY, whose entire effort is devoted to pioneering activities in new fields that it has opened up itself. One of these fields, for example, is that of ultra-high speed, ultra-compact digital computers and controllers. This company's JAINCOMP family of computers dominates this field. Other equally important fields are being developed. Engineers and physicists with sound backgrounds and experience in the design of advanced electronic circuits or precision mechanical instruments may qualify, also individuals with good backgrounds in applied physics. A few openings exist for outstanding junior E. E.'s and physicists, also experienced technicians; applicants for these positions must apply in person.

JACOBS
INSTRUMENT CO.
4718 Bethesda Ave.
Bethesda 14, Maryland

RCA TAPE RECORDER *Type RT-11A*

50 to 15,000 c.p.s. (±2 db) at 15 in/sec
50 to 7,500 c.p.s. (±2 db) at 7½ in/sec

COMPLETE—with motor board, plug-in type recording amplifier, plug-in playback amplifier, two standard NAB reels, power supply and panel and shelf.

- **Split-second start and stop**
- **Push-button operation**
- **Extremely accurate timing—with synchronous capstan**
- **Smooth tape runs—via sapphire guides**
- **Automatic tape lift for fast "forwards" and rewinds**
- **Microswitch "tape-break" control—no tape spills, snarls**
- **Remote control of all operations**
- **Rack or console mounting**
- **Plug-in amplifiers**
- **Interlock system for vital controls**
- **3 heads—Erase—Record—Playback**

PUSH-BUTTON CONTROL puts tape recording facilities at your fingertips.

NEW—

High-Fidelity Tape Recorder

—the finest money can buy!

Remote Control Unit, MI-11948. Available extra.

This is the world's foremost professional tape recorder, the one recorder that has *everything*—accurate timing, low wow and flutter, plus quick starting. All operations are push-button controlled. All functions—including cueing—can be extended to remote positions.

Designed for applications where operating TIME and RELIABILITY are prime factors, the new Type RT-11A Recorder offers a number of exclusive features. For example, you can start or stop the tape in 0.1 second. You can jockey the tape back and forth for cueing without stopping. You can rewind a standard 10½-inch reel in one minute!

A synchronous capstan makes it practical to hold recording time to ±2½ seconds in a 30-minute run. And with synchronizing equipment . . . for which provision is made . . . *timing can be held to 0.3 second on any length program!*

Many more important features, too.

Self-centering "snap-on" hub adaptors assure perfect reel alignment with either RMA or NAB reels. A complete system of control interlocking virtually eliminates the possibility of accidentally erasing a program—makes it impossible to snarl or "spill" the tape. "Microswitch" control stops the machine if the tape is severed—applies reel brakes instantaneously. The tape automatically lifts *free and clear* of heads during fast forward runs or rewinds. Tape alignment over the heads is held precisely by a floating casting. Starting wow is reduced to the vanishing point.

BY ALL MEANS, *call your RCA Broadcast Sales Engineer for complete details. Or mail the coupon.*

RCA

AUDIO BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

RCA Engineering Products,
Department 71L,
Camden, New Jersey

Send me more information (including price and delivery) on your new De Luxe Tape Recorder, Type RT-11A:

NAME_____

ADDRESS_____

STATION OR FIRM_____

CITY_____ STATE_____

TRANSMISSION-EQUIPMENT-DESIGN-ENGINEERS

West Coast manufacturer of carrier equipment plans expansion program in United States and Canada. Wishes to contact a small number of experienced telephone and telegraph engineers interested in permanent positions offering excellent futures in a well-established but expanding industry.

Several positions will become available during the next year. Salaries commensurate with training and experience will be arranged for men selected. Please give full details in first reply.

Lenkurt

Lenkurt Electric Co.
1105 County Rd., San Carlos, Calif.
926 East Hastings St., Vancouver, B.C.

ENGINEERS
ELECTRONICS RESEARCH AND DEVELOPMENT
In Baltimore, Maryland
Career Positions for Top Engineers and Analysts in

Radar Pulse, Timing and Indicator Circuit Design
Digital and Analogue Computer Design
Automatic Telephone Switchboard Design

Also
Electro-Mechanical Engineers

Experience in servo-mechanism, special weapons, fire control, and guided missile design.
Recent E.E. graduates and those with at least one year electronics research and development work will also be considered.
Salary commensurate with ability. Housing reasonable and plentiful. Submit resume outlining qualifications in detail. Information will be kept strictly confidential. Personal interviews will be arranged.

THE GLENN L. MARTIN COMPANY
Employment Department
Baltimore 3, Maryland

RESEARCH OPPORTUNITIES IN THE LOS ANGELES AREA

Unusual Opportunity for Senior men with degrees and at least five years of outstanding proven accomplishment to achieve further growth by working with some of the nation's outstanding scientists on commercial and military projects in large modern electronics laboratories.

ELECTRONIC ENGINEERS
PHYSICISTS—CIRCUITRY
PHYSICISTS—ANALYSIS
PHYSICISTS—OPTICS
PHYSICISTS—ELECTRON TUBES
SERVOMECHANISMS ENGINEERS
ELECTRO MECHANICAL ENGINEERS
MECHANICAL DESIGNERS

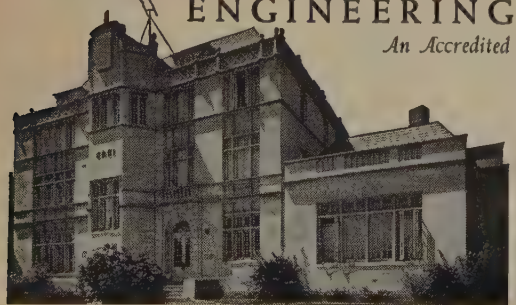
Long term program of research and development in the fields of Radar, Guided Missiles, Computers, Electron Tubes, and related equipment.

Please do not answer unless you meet the above requirements.

RESEARCH AND DEVELOPMENT LABORATORIES
Hughes Aircraft Company CULVER CITY, CALIFORNIA

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO
ENGINEERING INSTITUTE
An Accredited Technical Institute



ADVANCED HOME STUDY AND RESIDENCE COURSES IN PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING

Request your free home study or resident school catalog by writing to:

DEPT. 2612B
16th and PARK ROAD, N.W.,
WASHINGTON 10, D.C.
Approved for Veteran Training

Positions Wanted

(Continued from page 55A)

ANTENNA ENGINEER

B.S. and M.S. in E.E., extra graduate credit. 2 years Navy electronics, 1 year part time teaching, over 2 years aircraft antenna research and development work. Age 27, married. Eta Kappa Nu, Tau Beta Pi, A.I.E.E., I.R.E., Sigma Xi. Desires research and development in VHF, UHF or microwave antennas. Box 483 W.

COMMUNICATIONS ENGINEER

B.E.E. Clarkson College, June 1950. Single, age 26. Formerly A.A.F. radar technician. Metropolitan New York area preferred. Box 484 W.

TELEVISION ENGINEER

Presently employed, 28 months equipment design and advanced development; video, pulse and special associated circuits. Seeking permanent connection with future away from metropolitan New York area. Systems engineering preferred, but will consider research or development. Present salary $5400. Credentials on request. Box 485 W.

ELECTRONIC ENGINEER

M.S.E.E. electronics, University of Illinois 1949. Age 31, married. 4 years A.A.F. radar officer, instructor. 1 year radio manufacturing. Last year and a half in geophysics, still employed. Prefer midfest or southwest. Box 486 W.

ELECTRONIC ENGINEER

B.E.E. 1942. Age 30, married, 1 child. 9 years experience in research and development. Experience includes UHF, micro-

(Continued on page 59A)

PROJECT ENGINEERS

Opportunities exist for graduate engineers with design and development experience in any of the following:

ANALOGUE COMPUTERS
SERVO MECHANISMS
RADAR
ELECTRONIC CIRCUITS
COMMUNICATION EQUIPMENT
AIRCRAFT CONTROLS
HYDRAULICS
INSTRUMENTATION
ELECTRONIC PACKAGING
PRINTED CIRCUITS
PULSE TRANSFORMERS
FRACTIONAL H. P. MOTORS

Submit Resume to Employment Dept.

SPERRY GYROSCOPE CO.
Division of the Sperry Corp.
GREAT NECK, L.I., NEW YORK

PHYSICISTS AND SENIOR RESEARCH ENGINEERS

POSITIONS NOW OPEN

Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

- Microwave Techniques
- Moving Target Indication
- Servomechanisms
- Applied Physics
- Gyroscopic Equipment
- Optical Equipment
- Computers
- Pulse Techniques
- Radar
- Fire Control
- Circuit Analysis
- Autopilot Design
- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

NORTH AMERICAN AVIATION, INC.
Aerophysics Laboratory
Box No. N-4, 12214 South Lakewood Blvd.
Downey, California

Positions Wanted

(Continued from page 58A)

waves and servomechanisms. Interested in changing position. Box 495 W.

ENGINEER

Mature engineer, age 40 broad experience including industrial design, field engineer, foreign experience. B.S. in E.E. University of Illinois, UHF major. Now completing work for M.S. in E.E., physics emphasis in research. Domestic or foreign employment (supervision of overseas branch) will be considered. Box 496 W.

JUNIOR ELECTRONIC ENGINEER

B.E.E. June 1950, C.C.N.Y. Age 25. HAM class B license. Transmitter constructed by myself. Receiver maintenance in Navy. Interested in research or design and development. Resume on request. Box 497 W.

ELECTRONIC ENGINEER

B.E.E. Cooper Union. 4 years experience in radar and Government special apparatus; 1 year in Army radar maintenance; 1 year in television. Age 28, married. Desires position in development work. Box 498 W.

ELECTRICAL ENGINEER

B.S.E.E. Columbia, Tau Beta Pi, Age 31, married. 7 years development, production and administrative experience. Wide shop background, inventive ability, capable trouble shooter. Designed, developed, manufactured electronic controls for machinery, precision electro-mechanical devices. 2½ years Navy, radar and sonar instructor. New York metropolitan area. Box 499 W.

NATIONAL UNION RESEARCH DIVISION

Senior engineers and physicists are needed for research and development of Cathode Ray, Subminiature, Secondary Emission and highly specialized types of Vacuum Tubes.

Junior Electrical Engineers are desired for training as tube or circuit design engineers.

Men qualified by virtue of education or experience to handle problems in the field of tube or circuit design are invited to send their resumes to:

Divisional Personnel Manager
National Union Research Division,
350 Scotland Rd., Orange, N.J.

Positions available for

SENIOR ELECTRONIC ENGINEERS

with
Development & Design
Experience

in

MICROWAVE RECEIVERS
PULSED CIRCUITS
SONAR EQUIPMENTS
MICROWAVE COMMUNICATIONS SYSTEMS

Opportunity For Advancement
Limited only by Individual Ability

Send complete Resume to:
Personnel Department

MELPAR, INC.
452 Swann Ave.
Alexandria, Virginia

ENGINEERING OPPORTUNITIES IN Westinghouse

Wanted:

Design Engineers
Field Engineers
Technical Writers

Must have at least one year's experience.

For work on airborne radar, shipborne radar, radio communications equip., microwave relay, or micro-wave communications.

Good pay, excellent working conditions; advancement on individual merit; location Baltimore.

Send resume of experience and education to: Manager of Industrial Relations, Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Maryland.

RCA VICTOR Camden, N. J.

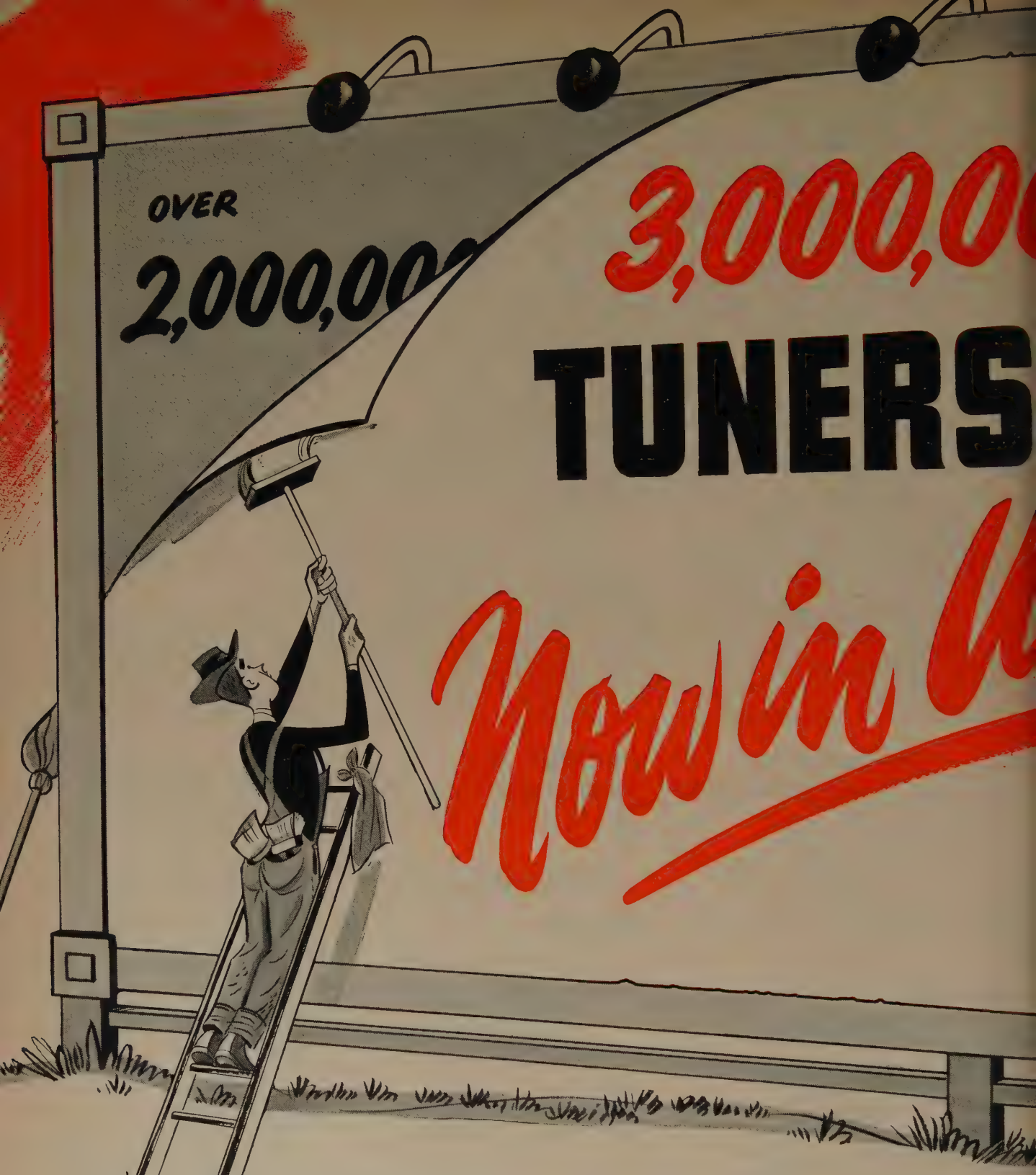
Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

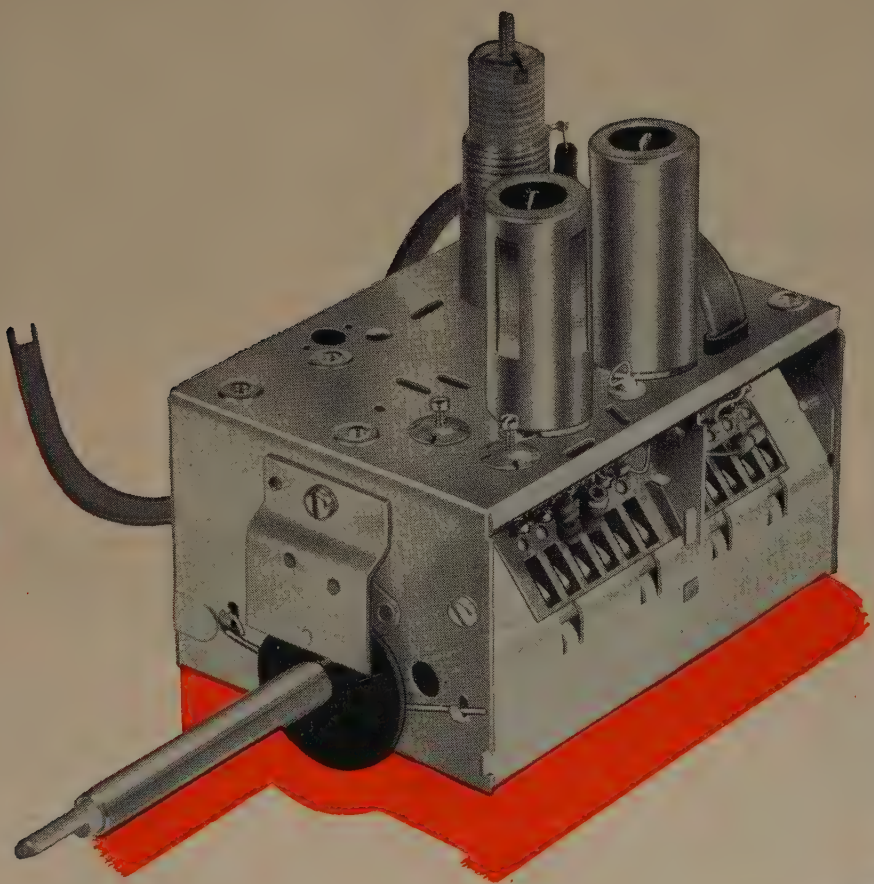
National Recruiting Division
Box 980, RCA Victor Division
Radio Corporation of America
Camden, New Jersey



OVER 75 TV SET MANUFACTURERS
USE "THE STANDARD TUNER"

Standard COIL PRODUCTS C

"Standard"



Chicago
Los Angeles
Bangor, Michigan

"THE STANDARD BOOSTER"
FOR FRINGE AREA RECEPTION

Specify CP TEF-LINE SUPER TRANSMISSION LINE

A new transmission line based upon a new plastic—TEFLON

CP TEF-LINE transmission line, utilizing DuPont Teflon insulators, greatly reduces high frequency power losses. Furthermore, operation of transmission line at frequencies heretofore impossible owing to excessive power loss now becomes easily possible. For TV, FM and other services utilizing increasingly high frequencies, TEF-LINE by CP is a timely and valuable development worthy of investigation by every user of transmission line.

ONE-PIECE
INNER CONDUCTOR
Seal-O-Flange Tef-Line is made of a single piece of copper tubing. Teflon disks are distributed to provide positive, permanent positioning.
COPPER INNER CONDUCTOR OF A TEF-LINE SEAL-O-FLANGE TRANSMISSION LINE SHOWING A ONE PIECE TEFLON INSULATING DISK FITTING INTO DEPRESSION FORMED IN THE TUBE WALL

CP SUPER TEF-LINE IS AVAILABLE NOW!

Tef-Line can be delivered immediately in three standard sizes—7/8", 1 5/8" and 3 1/8". With the exception of elbows and gas stops, the new Seal-O-Flange Super Transmission Line is interchangeable with all other CP fittings including end seals, tower hardware, flanges, "O" rings, inner conductor connectors and miscellaneous accessories.

Check your transmission line requirements with the new CP TEF-LINE BULLETIN which is available on request. If you need help in planning installations, our engineers will be happy to talk over specific problems at your convenience.

• TOWER HARDWARE • AUTO-DRYAIRE DEHYDRATORS
• LO-LOSS SWITCHES • COAXIAL DIPOLE ANTENNAS
• SEAL-O-FLANGE TRANSMISSION LINE

Communication Products Company, Inc.
KEYPORT CP NEW JERSEY

MEMBERSHIP

(Continued from page 49A)

Wisner, R. M., 807 Ninth St., Alamogordo, N. Mex.
Wolff, H. R., 5135 E. North St., Indianapolis 19, Ind.

Admission to Senior Member

Dawes, E. J., 10A Highbury Crescent, London N. 5, England
Herr, R. F., Cloverly Lane, Rydal, Pa.
Jones, R. M., 6733 Jean Ave., Chicago 30, Ill.
Mallach, L. W., 8349 Hatillo Ave., Canoga Park, Calif.
Millis, W. T., 219 Hubert Ct., Owensboro, Ky.
Pawley, M. G., 503 Fontaine St., Alexandria, Va.
Pollack, M., 35 W. 33 St., Chicago 16, Ill.

Transfer to Member

Bush, T. K., 3012 Virginia Ave., Charlotte, N. C.
Carlson, O. E., 25 Riverdale Rd., Pompton Lakes, N. J.
Christman, T. J., 925 Parkman St., Altadena, Calif.
Cooper, J. V. B., 32–44 Bell Blvd., Bayside, N. Y.
Cumming, W. A., Radio & Electrical Engineering Division National Research Council, Ottawa, Ont., Canada
Gundy, P. L., 519 N. Wilson, Royal Oak, Mich.
Harris, A. W., 3348 W. Compton Blvd., Gardena, Calif.
Kush, L. J., Jr., 816 W. Wells St., Milwaukee 3, Wis.
Levy, S. L., 102-15—65 Rd., Forest Hills, L. I., N. Y.
Lawrence, S. C., 1573 E. Forest, Detroit 7, Mich.
Lyle, I. W., Jr., Route 3, Jeffersontown, Ky.
Moore, J. C., Jr., 44 Waverly Pl., Red Bank, N. J.
Moore, W. H., 78-15—19 Dr., Jackson Heights, L. I., N. Y.
Straughn, W. L., Sr., 1254 Euclid St., Beaumont, Tex.
Rowe, H. N., Box E. Sta. E., 1702 Wayne St., Toledo, Ohio
Wybrow, E., 10435 Dunleer Dr., Los Angeles 64, Calif.

Admission to Member

Baird, L. I., B.A.R., Douglas Aircraft Co., El Segundo, Calif.
Blodget, R., Holland Rd., Holland, Pa.
Bostwick, W. E., 2615 Sandia Dr., Bel Air, Albuquerque, N. Mex.
Clark, G. F., 207 Mattison Ave., Ambler, Pa.
Doyle, E. M., 2100 Connecticut Ave., N. W., Washington, D. C.
Foodim, C., 122 Richbell Rd., Mamaroneck, N. Y.
Hale, E. M., Box 2180, Rm. 203, Houston 1, Tex.
Leach, J. H., 1778 E. West Highway, Silver Spring, Md.
Lipschitz, S., 7 Beechwold Rd., Saxonwold, Johannesburg, South Africa
Locus, S. S., 3303—43 Pl., Sandia Base Branch, Albuquerque, N. Mex.
Lorentzen, P. E., 5840 Third St., R. D. 1, Verona, Pa.
Martin, D. W., Box 319A, R. D. 1, Newtown, Ohio
Martin, R. E., 621 W. 172 St., New York 32, N. Y.
McBride, G. H., 1707 N. Julian Blvd., Amarillo, Tex.
Nyhen, E. M., 12 Kent Sq., Brookline 46, Mass.
Olson, E. L., 329 S. Wood St., Chicago 12, Ill.
Pierce, C. B., 8223 Kilpatrick Ave., Skokie, Ill.
Reeves, J. M., Information Department, Box 209, Lusaka, Northern Rhodesia
Reiner, M., 19 E. 88 St., New York 28, N. Y.
Rueggeberg, W., Research Laboratories, Armstrong Cork Company, Lancaster, Pa.
Savage, W. B., Wick House, Potterne Wick, Devizes, Wilts., England
Tucker, R. E., 7623 Camellia Ave., N. Hollywood, Calif.

(Continued on page 64A)

REVERE FREE-CUTTING COPPER ROD
. . . INCREASES ELECTRONIC PRODUCTION

SINCE its introduction, Revere Free-Cutting Copper has decisively proved its great value for the precision manufacture of copper parts. Uses include certain tube elements requiring both great dimensional precision, and exceptional finish. It is also being used for switch gear, high-capacity plug connectors and in similar applications requiring copper to be machined with great accuracy and smoothness. This copper may also be cold-upset to a considerable deformation, and may be hot forged.

Revere Free-Cutting Copper is oxygen-free, high conductivity, and contains a small amount of tellurium, which, plus special processing in the Revere mills, greatly increases machining speeds, makes possible closer tolerances and much smoother finish. Thus production is increased, costs are cut, rejects lessened. The material's one important limitation is that it does not make a vacuum-tight seal with glass. In all other electronic applications this special-quality material offers great advantages. Write Revere for details.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue
New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities, Distributors Everywhere.

CUSTOMERS REPORT:

"This material seems to machine much better than our previous hard copper bar; it cuts off smoothly, takes a very nice thread, and does not clog the die." (Electrical parts.)

"Increased feed from 1-1/2" to 6" per minute and do five at one time instead of two." (Switch parts.)

"Spindle speed increased from 924 to 1161 RPM and feed from .0065" to .0105" per spindle revolution. This resulted in a decrease in the time required to produce the part from .0063 hours to .0036 hours. Material was capable of faster machine speeds but machine was turning over at its maximum. Chips cleared tools freely, operator did not have to remove by hand." (Disconnect studs.)

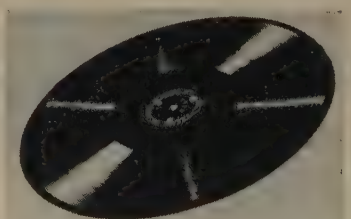
PRESTO...*most carefully made recording discs in the world*

step 4 - Inspection is important

Surface reflections in a recording disc can tell more than volumes to the skilled eye. That's why no mechanical test has ever replaced the examination of each PRESTO disc by trained inspectors.

Under a bank of fluorescent lamps diffused by a special glass screen, discs are slowly rotated. A ripple, a fleck in the brilliant surface automatically grades the disc. Only those passing the most critical surface test are allowed to carry the PRESTO "Green Label."

Rigid inspection of discs is further insurance that your instantaneous or master recording will produce full tonal quality, that it will react properly under recording, processing and playback conditions. This important fourth step in the manufacture of PRESTOS is another reason why they are known throughout the world as the most carefully-made, most permanent, best performing discs available.



The famous PRESTO "Green Label" . . . world's finest recording disc.

PRESTO
RECORDING CORPORATION
Paramus, New Jersey
Mailing Address:
Box 500, Hackensack, New Jersey

In Canada:
Walter P. Downs, Ltd.
Dominion Sq. Bldg.
Montreal, Canada

Overseas:
M. Simons & Son Co., Inc.
25 Warren Street
New York, New York

MEMBERSHIP

(Continued from page 62A)

Van Arsdell, J. C., Jr., Erie Resistor Corporation, 644 W. 12, Erie, Pa.
Rhiger, R. R., 227 S. E. 52 Ave., Portland 15, Ore.
Schimpf, R. G., 6510 Fairfield Ave., Berwyn, Ill.
Wellinger, R. P., 403 S. Lincoln, Urbana, Ill.
White, W., 251 Ivon Ave., Hamilton, Ont., Canada

The following elections to Associate were approved and are effective as of November 1, 1950:

Algiers, E. P., 6113—26 Ave., Kenosha, Wis.
Anderson, C. M., 1025 Wisconsin Ave., Oak Park, Ill.
Anderson, C. L., 880 Bloomfield Ave., Akron, Ohio
Andrade, L., 30 Ave. D, New York 9, N. Y.
Artificer, A., Station Workshops, Jubbulpore, India
Bauer, J. W., Jr., 309 Acme St., Cheswick, Pa.
Basil, I. T., 3231 Lyndale Ave., Baltimore, Md.
Bazik, W., 22741 Mastik Rd., Cleveland 26, Ohio
Benzuly, H. J., 1140 N. Elmwood Ave., Oak Park, Ill.
Bhote, K. R., 826 S. Wabash Ave., Chicago 5, Ill
Blacketer, J. R., 7636 Carr St., Dallas, Tex.
Bowers, P. E., Armour Research Foundation, 35 W. 33 St., Chicago 16, Ill.
Cartwright, L. W., 3348 Smedley St., Philadelphia, Pa.
Chin, E., 27 Mercer St., Hackensack, N. J.
Corduan, A. E., 6946 Woodley Ave., Van Nuys, Calif.
D'Arcy, E. W., DeVry Corp., 1111 Armitage Ave., Chicago, Ill.
Dellekamp, K. J., Technology Center, Armour Research Foundation, Chicago, Ill.
DeRosa, T. T., 4102 Ave. P, Brooklyn 34, N. Y.
Donaldson, W. G., 80 Lafayette St., New York 13, N. Y.
Drexler, J., 129 Paine Ave., Irvington 11, N. J.
Dunlavey, E. O., 7159 S. Fairfield, Chicago, Ill.
Edelstein, H. N., 1137 Nameoke St., Far Rockaway, L. I., N. Y.
Eggerton, W. H., 27 W. Cuthbert Rd., Collingswood 7, N. J.
Farrance, J., 18913 Parkmount Ave., Cleveland, Ohio
Ferreira, R., CPO-1, U.S.N.T.C., San Diego 33, Calif.
Filips, R. P. 4953 S. Justine St., Chicago, Ill.
French, G. J., 208 Ashland Ave., Pittsburgh 28, Pa.
Gannon, M. J., 607 Hulton St., Carnegie, Pa.
Geschwind, R. A., 359 Delmar St., Philadelphia, Pa.
Giesecke, H. W., 500 Alabama Rd., Towson 4, Md.
Goublin, R. O., 3 Ave. Eugenie, St. Cloud, Seine Et Oise, France
Green, R. G., 438 S. Union Dr., Los Angeles 13, Calif.
Gruen, H. E., 12131 S. Princeton, Chicago 28, Ill.
Haas, M. L., Radio & Electronics Parts Corp., 3235 Prospect Ave., Cleveland 15, Ohio
Hainey, C. P., 6215 Vickery, Dallas 14, Tex.
Handelman, S. M., 22 Brevoort Pl., Brooklyn, N. Y.
Herzog, W. F., 120 Steele Ave., Dayton, Ohio
Hood, H. E., 2905 Skyline Blvd., Bakersfield, Calif.
Jennings, T. F., 5052 Sargent Rd., N. E., Washington, D. C.
Joering, E. R., 4316 Crystal Ave., Chicago 51, Ill.
Johnson, E. M., 3 Waite Pl., Troy, N. Y.
Jones, D. M., 38-B Bruan Pl., Richford Village, Clifton, N. J.
Jones, W. T., 2522 Idaho St., Dallas 16, Tex.
Johns, P., 10308 Parkview Ave., Cleveland 4, Ohio
Kaminski, H. S., 4363 N. Kenmore, Chicago, Ill.
Karel, L. G., 6231 S. Stewart Ave., Chicago 21, Ill.
Karp, P. W., 3826—25 St., San Francisco, Calif.
Katella, A. J., 6889 Waldorf Ave., Pennsauken, N. J.
Kern, G. A., 29-B Addison Pl., Clifton, N. J.
Klein, E. F., 528—35 St., Box 78, Los Alamos, N. Mex.
Korman, G., 18 N. Third St., Newark, N. J.
Krug, J. A., 2900—44 St., N. W., Washington 16, D. C.

(Continued on page 66A)

WILCOX ...FIRST CHOICE of HAWAIIAN AIRLINES

VHF AIR-BORNE COMMUNICATIONS

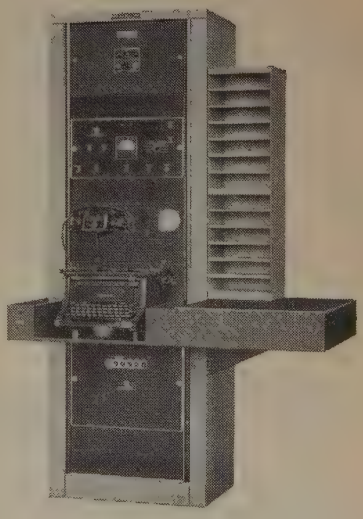
Hawaiian Airlines selected the WILCOX TYPE 361A COMMUNICATIONS SYSTEM for all aircraft. This consists of a 50 watt transmitter, a high sensitivity receiver, and a compact power supply, each contained in a separate ½ ATR chassis. Transmitter and receiver contain frequency selector with provisions for 70 channels . . . ample for both present and future needs.

VHF GROUND STATION PACKAGED RADIO

Hawaiian Airlines selected the WILCOX TYPE 428A FACTORY PACKAGED STATION for all ground stations. This consists of the WILCOX 406A fixed frequency 50 watt transmitter, the WILCOX 305A fixed frequency receiver, the WILCOX 407A power supply, the WILCOX 614A VHF antenna, telephone handset, loudspeaker, desk front, typewriter well, and message rack.

DEPENDABLE COMMUNICATIONS FOR THE WORLD'S AIRLINES

During recent months, many of the world's foremost airlines, UNITED, EASTERN, TWA, MID-CONTINENT, BRANIFF, PIONEER, ROBINSON, and WISCONSIN CENTRAL have placed volume orders for similar communications equipment. No greater compliment could be paid to the performance, dependability, and economy of WILCOX equipment than to be **"FIRST CHOICE"** of this distinguished group.



Type 428 Packaged VHF Station

Write Today for complete information on the Type 361A VHF Air-borne Communications System and the Type 428 Packaged VHF Ground Station.

WILCOX ELECTRIC COMPANY

KANSAS CITY 1, MISSOURI, U.S.A.

WHEN YOU NEED A MINIATURE TRANSFORMER

CHECK
THESE FEATURES OF THE
HORNET

✓ **SIZE AND WEIGHT** Because they are designed for high operating temperatures, Hornet Transformers and Reactors have only about one-fourth the size and weight of Class A units of comparable rating.

✓ **VOLTAGE RATINGS** Designs are available for RMS test voltages up to 10,000 volts at sea level, and up to 5,000 volts at 50,000 feet altitude. Power ratings from 2VA to 5KVA.

✓ **POWER FREQUENCIES** These units are designed to operate on 380/1600 cps aircraft power supplies, 60 cps power supplies, and any other required power frequency.

✓ **AMBIENT TEMPERATURES** Hornet Units can be designed for ambient temperatures up to 200 deg. C. Size for any given rating depends upon ambient temperature and required life.

✓ **LIFE EXPECTANCY** Extensive tests indicate that the life expectancy of Hornet units at continuous winding temperatures of 200 deg. C. is over 50,000 hours.

✓ **MOISTURE RESISTANCE** Since Hornet Transformers and Reactors contain only inorganic insulation, they are far more moisture resistant than conventional Class A insulated units.

✓ **EFFICIENCY** Regulation and efficiency of Hornet Transformers compare favorably with Class A units.

✓ **SPECIFICATIONS** Hornet Transformers meet the requirements of Government specifications covering this type of equipment.

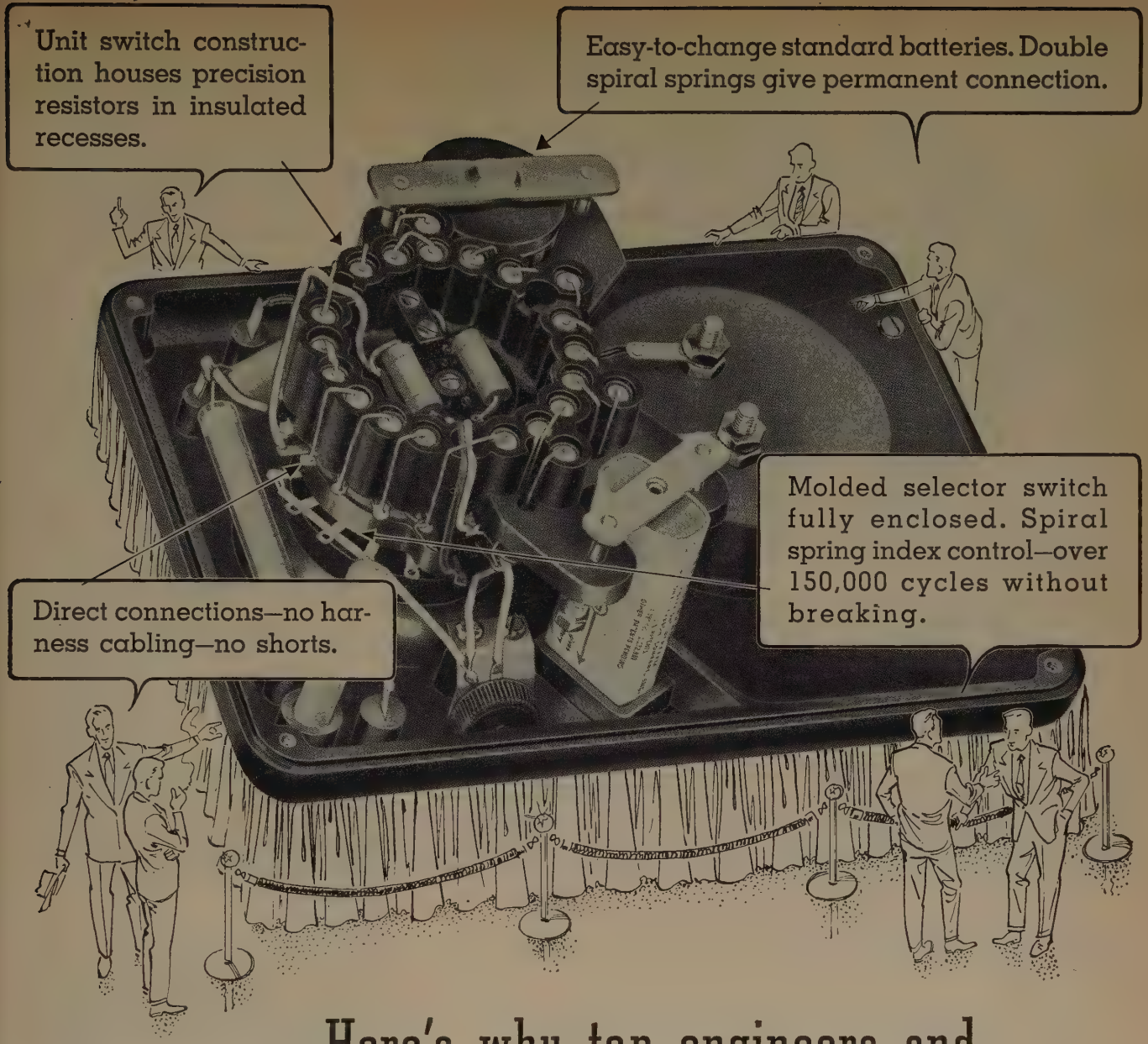
Bulletin B300, containing full electrical and dimensional data on Hornet units, is now available. Write for it, or tell us your specifications for special units.

NEW YORK TRANSFORMER CO., INC.
ALPHA NEW JERSEY

MEMBERSHIP

(Continued from page 64A)

Kuranuki, L. A., 91 Old Mill Rd., Great Neck, L. I., N. Y.
Kurinsky, J. S., 5133 N. Oak Park Ave., Chicago, Ill.
Lawson, M. H., 12926 Short Ave., Venice, Calif.
Levers, E. O., 45-23—259 St., Great Neck, L. I., N. Y.
Liebersohn, A., 248–252 Hewes St., Brooklyn 11, N. Y.
Lubeck, W. A., 2549 W. Winnemac Ave., Chicago 25, Ill.
Luzer, H. J., 1707 Van Dyke, Detroit 14, Mich.
MacDermott, J. G., 831 Paul St., Gloucester City, N. J.
Maed, A. S., Regharpura Gali 58 House, 4378 Karolbagh, New Delhi, India
Malinowski, S., 5306 W. Foster Ave., Chicago 30, Ill.
Margolis, A. B., 105 E. 106 St., New York, N. Y.
Marsland, H. W., 20 N. Wacker Dr., Chicago, Ill.
Milek, J. T., Hughes Aircraft Company, Culver City, Calif.
Moller, B. N., 623 Hecker, Belleville, Ill.
Morgan, J. F., 2 Parsy Pl., Great Neck, L. I., N. Y.
Morrow, E. E., 9574 Patton Ave., Detroit 23, Mich.
Neff, R. R., 5905 N. Paulina, Chicago, Ill.
Olson, R. E., 21 E. Johnson Ave., Bergenfield, N. J.
Perry, F. E., 12421 First Ave., S., Seattle, Wash.
Petranek, L., 1279 Third Ave., New York 21, N. Y.
Pettus, R., 2319 E. 83 St., Cleveland, Ohio
Polcuch, A. F. G., 9253 Meridian, Seattle, Wash.
Raffel, L., 136 Orient Ave., Jersey City 5, N. J.
Rajan, K. T., Institute of Technology, Trichur, S. India
Read, R. W., 272 Westgate, W., Cambridge 39, Mass.
Rety, E. E., 1607 Belmar Rd., E. Cleveland, Ohio
Richardson, W. R., 303 Broadmoor Rd., Baltimore 12, Md.
Riley, H. E., Port Arthur College, Box 511, Port Arthur, Tex.
Romanyszyn, M. T., 1345 Merriam Ave., New York 52, N. Y.
Rugg, D. A., 1308-A E. Curtis Pl., Milwaukee 2, Wis.
Russell, C. A., 100 S. Edgefield, Dallas, Tex.
Sander, W. E., LaVista Pl., Atlantic, Iowa
Scarborough, D. S., 724 Costa Rica Ave., San Mateo, Calif.
Schultze, W. J., 875 Richmond Ave., Buffalo, N. Y.
Seaton, G., 14314 Ledgewood, Cleveland 11, Ohio
Shannon, G. C., 1640 Belmont Ave., New Hyde Park, N. Y.
Shubel, E. J., 144-08—71 Ave., Flushing, L. I., N. Y.
Slobodin, L., 3211 Quentin Rd., Brooklyn, N. Y.
Smith, R. S., Rt. 2, Box 103, Harrisonburg, Va.
Songayllo, A., Jr., 3255 W. Sunnyside Ave., Chicago, Ill.
Sourek, R. A., 12613 Craven Ave., Cleveland 5, Ohio
Sprague, W. C., 153-C Victoria Dr., Pittsburgh 27, Pa.
Spranger, P. B., 3337 Freer St., Arcadia, Calif.
Steele, S. E., 79 Hamilton St., Berea, Ohio
Trbouich, J., 737 Large Ave., Clairton, Pa.
Treillard, C. E., 7754 Belsrano, Buenos Aires, Argentina
Uhlman, J. C., Box 3, Lac Du Bonnet, Man., Canada
Walters, W. H., 4506½ W. 59 Pl., Los Angeles 43, Calif.
Warzecha, T. D., 1740 N. Wood St., Chicago, Ill.
Welter, L. J., 2395—17 St., Wyandotte, Mich.
White, H. A., 148 Hendrickson Ave., Rockville Centre, N. Y.
Zaruba, E. J., 613 S. Yale Ave., Villa Park, Ill.
Zupansky, M., 5327 N. Winthrop Ave., Chicago 40, Ill.


Unit switch construction houses precision resistors in insulated recesses.
Easy-to-change standard batteries. Double spiral springs give permanent connection.
Molded selector switch fully enclosed. Spiral spring index control—over 150,000 cycles without breaking.
Direct connections—no harness cabling—no shorts.

Here's why top engineers and technicians use Model 630

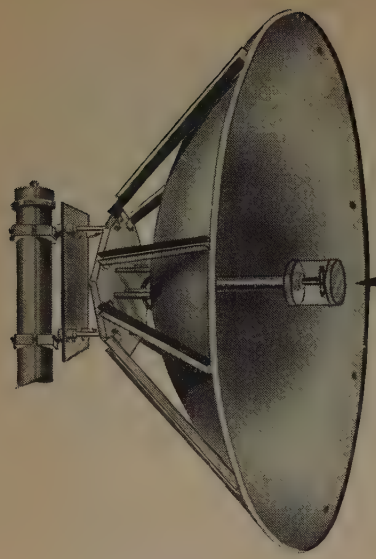
Features like those shown above are what make this popular V.O.M. so outstandingly dependable in the field. The enclosed switch, for instance, keeps the silvered contacts *permanently clean*. That's rugged construction that means stronger performance, longer life. And tests show that the spiral spring index control, after more than 150,000 cycles of switch rotation, has no disruption or appreciable wear! Investigate this history-making Volt-Ohm-Mil-Ammeter today: 33 ranges, large 5½" meter.

ONLY
$39.50
AT YOUR DISTRIBUTOR

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY · BLUFFTON, OHIO, U.S.A.



WHAT ARE *Your* REQUIREMENTS IN PARABOLIC ANTENNAS ?

For microwave systems . . . check these advantages of ANDREW Parabolic Antennas:

- ☐ **DEPENDABILITY**—*An actual record of 100% dependability.* There has *never* been a single mechanical or electrical failure on an ANDREW Parabolic Antenna . . . anywhere in the world.
- ☐ **COST**—Exceptionally low; made possible by high production.
- ☐ **LIGHT WEIGHT—HIGH STRENGTH**—Achieved by spun aluminum reflectors braced by formed steel struts.
- ☐ **ADJUSTABLE MOUNTING**—Through ± 10 degrees in azimuth and elevation.
- ☐ **DEICING KITS**—Thermostatically controlled, available where required.
- ☐ **CABLE**—7/8" air dielectric Teflon insulated cable. Radiator is pressure tight. Fittings for solid dialectric cables also available.

SPECIFICATIONS

Frequency Range	...890-960 MCS...				...1750-2110 MCS...			
Type Number	1002	1004	1006	1010	2002	2004	2006	2010
Diameter of Parabola feet	2	4	6	10	2	4	6	10
Gain Over Half Wave Dipole Decibels	10	15	20	25	15	20	25	29
Beam Width, Half Power Points, Degrees	36°	22°	16°	11°	18°	10°	7°	5°
Net Weight, Pounds	10	64	150	380	10	65	150	380
Thrust Due to Wind Loading at 30 Pounds/FT Pounds	127	509	1145	3200	127	509	1145	3200

Andrew CORPORATION
363 EAST 75th STREET • CHICAGO 19

Your antenna problems can best be solved by ANDREW—the largest firm of antenna equipment specialists in the world. Write today.

ANDREW

WORLD'S LARGEST ANTENNA EQUIPMENT SPECIALISTS

TRANSMISSION LINES FOR AM-FM-TV • ANTENNAS • DIRECTIONAL ANTENNA EQUIPMENT
ANTENNA TUNING UNITS • TOWER LIGHTING EQUIPMENT

News New—Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

Radiation Detection Meters

A radioactivity-measuring instrument, the Universal Roentgen Meter, is now being produced by **Westinghouse Electric Corp.**, Box 2099, Pittsburgh 30, Pa.

The meter is the measuring part of radiation detection devices which reveals radiation, expressed in milliroentgens, that the device detects, thus indicating the amount of radioactivity present in any area.

The meter is equipped with multiple scales, either four, five or six, which make possible fine readings in all ranges of radiation. The four scale model covers four ranges of radiation: 0 to ½ milliroentgen; 0 to 5 milliroentgens; 0 to 50 milliroentgens; and 0 to 500 milliroentgens.

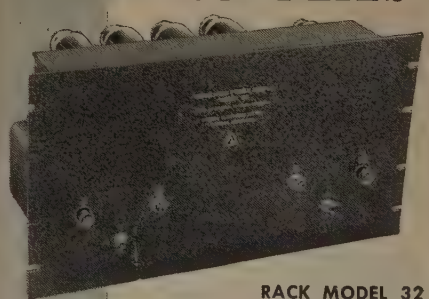
Setting a switch determines which of the multiple scales will operate and will be visible, thus eliminating incorrect reading by use of the wrong scale.

The instrument is sensitive enough for use in X-ray work, but also accurately measures large amounts of radiation encountered in atomic fission research.

(Continued on page 70A)

ELECTRONICALLY REGULATED

LABORATORY POWER SUPPLIES



RACK MODEL 32

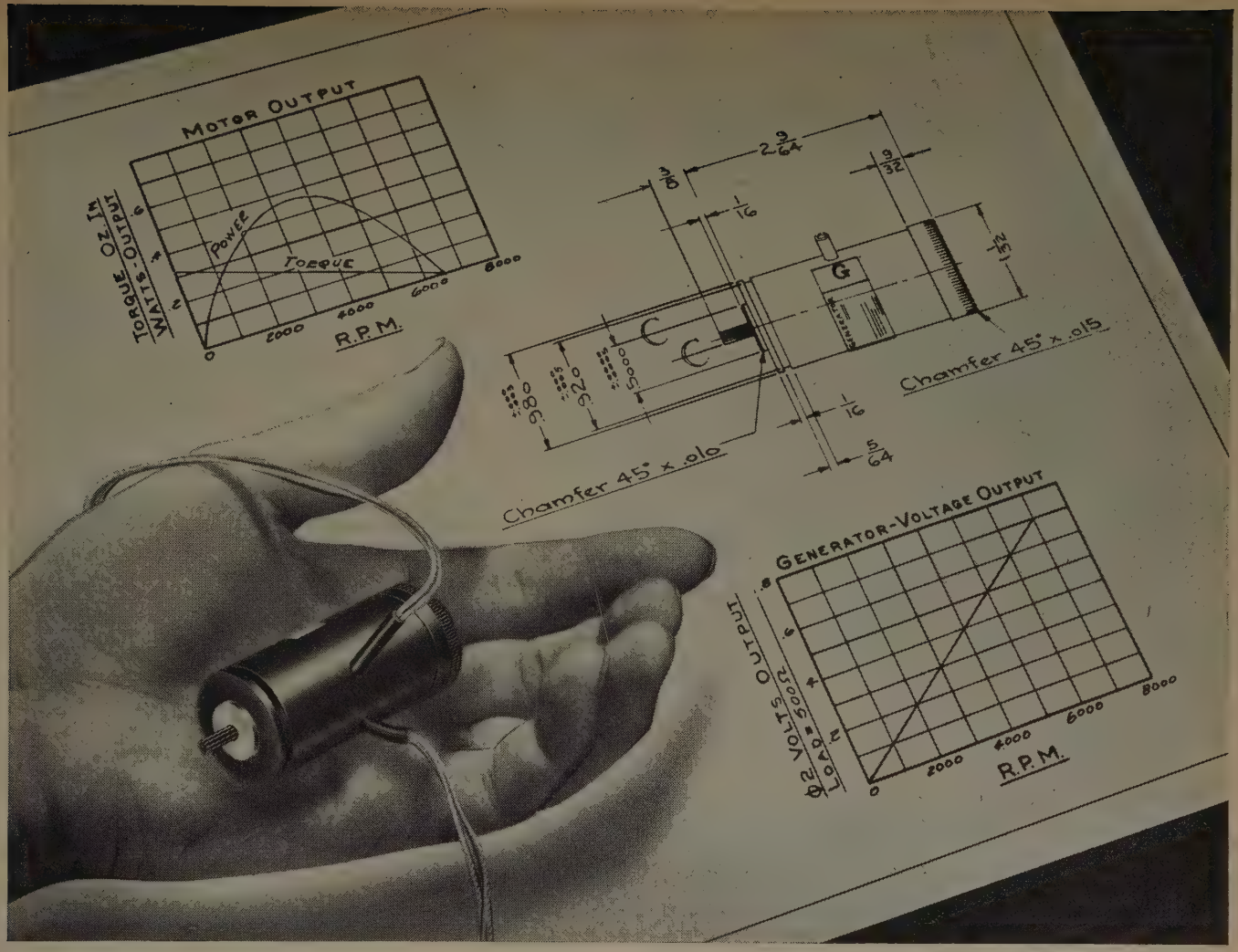
• STABLE • DEPENDABLE • MODERATELY PRICED •

STANDARD RACK MOUNTING
PANEL SIZE 10½" x 19"
DEPTH 9"
WEIGHT 38 LBS

- INPUT: 105 to 125 VAC, 50-60 cy
- OUTPUT #1: 200 to 325 VDC at 300 ma regulated
- OUTPUT #2: 6.3 Volts AC CT at 5A unregulated
- OUTPUT #3: 6.3 Volts AC CT at 5A unregulated
- RIPPLE OUTPUT: less than 10 millivolts rms

For complete information write for Bulletin G-2

LAMBDA ELECTRONICS CORPORATION
CORONA NEW YORK



Remarkable new compactness in precision control

The extreme compactness of the new Type 1623 Motor-Driven Induction Generator has been achieved with no sacrifice of general performance characteristics. Like its "bigger brothers" in the Kollsman line, the Type 1623 combines, in a single frame, motors of high torque/inertia ratio with generators offering *linear voltage vs. speed* over a wide range.

Where size and weight are prime considerations, this 4.2-ounce unit will prove the solution to many precision control problems. Separate induction motors and generators are also available in the same diameter frame.

For further information on the 1623 and others in the complete Kollsman group of miniature special purpose AC motors—or if you require a unit to your own specifications—write: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

Type 1623 Motor-Driven Induction Generator

Motor characteristics: Maximum torque at stall—smooth-running (will not "cog")—fast-reversing—operates from two-phase source, or from single-phase with phase-shifting condenser—available for 60 or 400 cycle operation.

Generator characteristics: Low residual voltage and voltage "spread"—constant frequency output—amplitude directly proportional to speed.

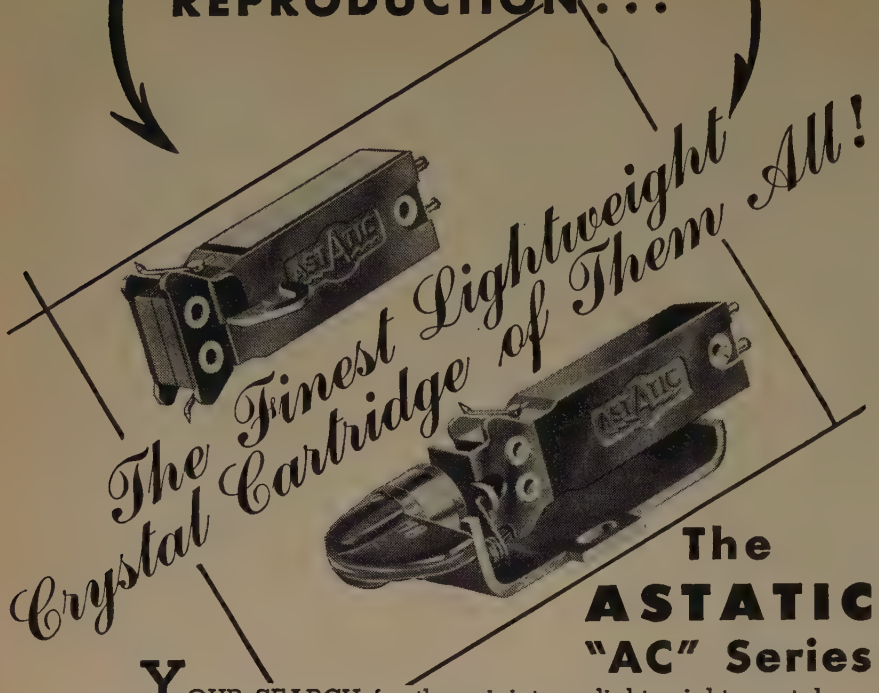
Unit characteristics: Both rotors mounted on same shaft, assuring positive alignment—stainless steel housing—hardened beryllium copper shaft—corrosion-resistant nickel steel laminations—high temperature insulation (up to 200° C. total temperature)—stainless steel precision ball bearings—weight: 4.2 ounces.

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA

BY EVERYTHING MODERN IN RECORD REPRODUCTION . . .



The ASTATIC "AC" Series

YOUR SEARCH for the miniature, lightweight crystal cartridge with smoothest response characteristics, highest tracking excellence and low needle talk will now end with Astatic's new "AC" Series. Essentially, it's a matter of a new mechanical drive system which affords a new low inertia. The results are definitely superior overall performance. Put the "AC" through its paces yourself . . . note that the general excellence of frequency response is especially fine in the high frequencies. "AC" Cartridges use the new Astatic Type "A" Needle, easily replaceable without tools on the same holding principle as the famous Astatic Type "Q" Needle.

THE Astatic CORPORATION
ASTATIC
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

SPECIFICATIONS

Model	List Price	Minimum Needle Pressure	Output Voltage 1000 c.p.s. 0.5 Meg Load	Frequency Range c.p.s.	Needle Type	For Record	Code
AC-78-J	$ 8.90	6 gr.	1.0*	50-10,000	A-3 (3-mil sapphire tip)	Standard 78 RPM	ASWYN
AC-J	8.90	5 gr.	1.0**	50-10,000	A-1 (1-mil sapphire tip)	33-1/3 and 45 RPM	ASWYJ
AC-AG-J	8.90	6 gr.	1.0**	50-10,000	A-AG† (Sapphire tip)	33 1/3, 45 and 78 RPM	ASWYH
DOUBLE NEEDLE TURNOVER MODELS:					1-mil tip needle for LP 33-1/3 and 45 RPM records. 3-mil tip needle for standard 78 RPM records.		
ACD-J	9.50	6 gr. either needle	1.0**	50-6,000	A-1 and A-3 (sapphire tips)	33-1/3, 45 and 78 RPM	ASWYL
ACD-1J	9.50	(Same as ACD-J except equipped with spindle for turnover knob. Replacement cartridge for ACD-2J assembly.)					ASWYF
ACD-2J	10.00	(Same as ACD-J except equipped with complete assembly turnover and knob.)					ASWYE

†"ALL-GROOVE" Needle tip of special design and size to play either 33-1/3 and 45 RPM (narrow groove) or 78 RPM (standard groove) records.

*Audiotone 78-1 Test Record
**RCA 12-5-31V Test Record

Astatic Crystal Devices manufactured under Brush Development Co. patents

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 68A)

Dual Spotlight Soldering Gun Eliminates Shadows

Dual spotlights to eliminate shadows, and over/under terminals to brace tip and improve visibility are features of the new light-duty soldering gun recently announced by **Weller Electric Corp.**, 821 Packer St., Easton, Pa.

This new model is considerably smaller and lighter than previous, now obsolete, 135-watt guns, and yet has substantially greater soldering capacity.

The gun has dual heat, 100/135 watts, for all light and delicate soldering, 5-second heating to save time and current, trigger-switch control which adjusts heat to the work, and eliminates need of unplugging gun between jobs.

(Continued on page 72A)

The nonmelting SILICONE insulating and waterproofing compound that is stable at temperatures from -70°F. to +400°F.

DOW CORNING 4 COMPOUND

↓ for ELECTRONIC EQUIPMENT

↑ for AIRCRAFT ignition and electrical control systems

MEETS ALL THE REQUIREMENTS OF AN-C-128a

More water repellent than paraffin, Dow Corning 4 Compound is highly resistant to oxygen, ozone and to deterioration caused by corona discharge.

POWER FACTOR, up to 10 megacycles . . . 0.001
VOLUME RESISTIVITY, ohm centimeters . . 10^{15}
DIELECTRIC STRENGTH, volts/mil 500

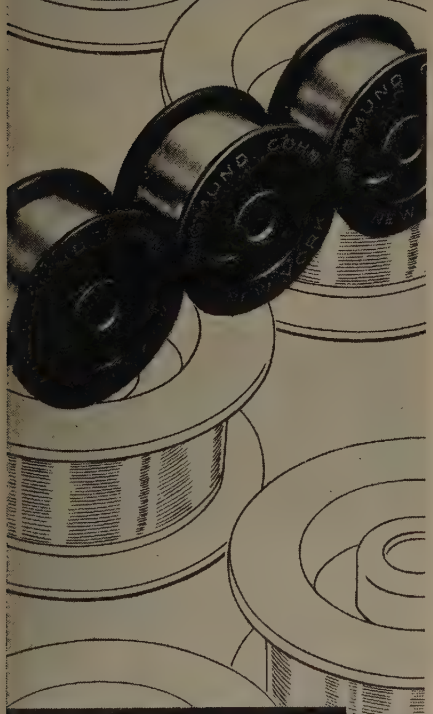
Write Today! for your copy of our new booklet on Dow Corning 4 Compound Address Dept. D.

Dow Corning FIRST IN SILICONES

DOW CORNING CORPORATION, Midland, Michigan

Gold Plated

TUNGSTEN and MOLYBDENUM GRID WIRE



Made to meet your specifications . . . for gold content, diameter and other requirements.

Write for details and list of products

SIGMUND COHN CORP.

44 GOLD ST. NEW YORK

SINCE 1901

NEW SYSTEM Accurately measures VSWR from 1.02 to 100/1

ROLLIN

DOUBLE PROBE SYSTEM

REFERENCE LABORATORY STANDARD

PRECISION

SLOTTED LINE & VSWR INDICATOR

MEASURES

IMPEDANCE • VSWR

RELATIVE POWER

100 MC TO ABOVE 1000 MC

SWR INDICATOR— STABLE SENSITIVE 1000 CYCLE NEGATIVE FEED BACK AMPLIFIER FLAT TOP SELECTIVITY.

NEGLIGIBLE REFLECTIONS

PIN POINT TYPE PROBE

"HARDWAYS" PRECISION HANDWORKED SURFACE

MODEL 62

MIN. GENERATOR RF. POWER REQ. 2-20 MILLIWATTS

- Full scale VSWR ranges: 1.1/1 - 4.0/1 - 10./1 and to 100/1 using included calibrated probe depth attenuators.
- Differential probe system for accurate measurement of low VSWR.
- Useable electrical probe travel 150 centimeters (½ wave at 100 mc/s).
- Removable end tapers exhibit negligible impedance transformation—under 1%.
- Residual VSWR under 1%—voltage uniformity ± 0.5% or better—mechanical tolerances held to 0.2%.
- Machine engraved centimeter scale and vernier (Starrett) measures probe travel to 0.1 millimeter accurate to 0.01mm.
- Continuously adjustable probe depth 0—.500" calibrated in .001" steps. Permits measurements of relative power and maintenance of square law crystal characteristic.

ROLLIN

THE ROLLIN COMPANY

2070 N. FAIR OAKS AVE. • PASADENA 3, CALIFORNIA

Two Bolometer Amplifiers

MODEL 100

- Variable Bandwidth
- Tunable Frequency Range
- Voltage Ratio Expander
- Automatic Normalization
- Self Contained Metering
- Recorder Output

USES

The P & B Bolometer Amplifier Model 100 is a quality amplifier designed for use in connection with making electrical measurements of antennas and associated radio-frequency systems. Standing wave ratios may be quickly determined on either a linear or expanding indicating scale.

The tunable, variable bandwidth, band-pass characteristics of the amplifier make it useful where conditions might render other test equipment useless.

Built to Navy Specifications for research and production testing.

CHARACTERISTICS

Frequency range—400 cycles—5,000 cycles (± 3% calibration accuracy).

Bandwidth—(1/2 voltage) 6, 12, 22, 50, 100 and 300 cycles.

Input Voltage Range
Signal Channel—10^{-2}—10^{-7} volt.
Monitor Channel—10^{-2}—10^{-5} volt.
Expander Operation—10^{-2}—10^{-5} volt.

Input Impedance—250 ohm to 350 ohm.

Meter—logarithmic scale with 100 db decade.

Recorder Output—.01—100 volts @ .01 w. max. (undecaded).

Normalization—output voltage holds within ± ¼db for input changes of ± 5db to both channels.

Bolometer Bias—adjusted in steps of 5% current change over range of 2:1 metered directly.

Voltage Ratio Expander—eighth power expansion.

Power Supply—105/115 volts 50/60 cycles, 175 watts.

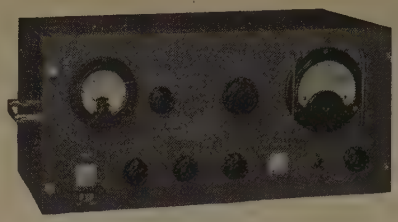
Dimensions—19½" high, 17¼" wide, 12" deep.

Weight—65 lbs.

Finish—Blue-grey—Wrinkle.

Ask for Bulletin L-100

MODEL 60



- Self Contained Metering
- Pull Out Meter
- AC and DC Recorder Output
- Panel Selection of 3 Frequencies
- Adjustable and Metered Bolometer Bias

USES

The Model 60 Bolometer Amplifier is a band pass amplifier designed to amplify the output of crystal or bolometer probes used in RF measuring equipment. The amplifier is suitable for all occasions where extremely low audio voltages must be amplified. The recorder output makes the unit particularly useful for antenna pattern recorders requiring either AC or DC input voltages.

DESCRIPTION

The Model 60 Bolometer Amplifier is an audio amplifier incorporating parallel 'T' null networks in a feed back circuit to provide a narrow band pass at any desired frequency within specified limits. The amplifier includes a meter amplifier and an output meter which may be removed from the panel opening for use at remote locations. The recorder output provides a choice of impedances for AC outputs as well as a DC output for those recorders requiring such an input. Input circuits are designed for operation with crystals or 300 ohm bolometers.

CHARACTERISTICS

FREQUENCY RANGE—400 cycles to 5000 cycles (choice of 1, 2, or 3 frequencies within these limits) ±2% frequency tolerance.

BANDWIDTH—(½ voltage points) 8% of bandpass center frequency.

INPUT VOLTAGE RANGE
Meter—10^{-2}–10^{-7} volt
Recorder (AC)—10^{-2}–10^{-6} volt

INPUT IMPEDANCE—250 ohm to 350 ohm.

METER—Logarithmic meter scale (0-20 db) with 100 db decade.

RECORDER OUTPUT—AC .01-100 volts @ 50,000 ohms. Additional output impedances of 5000 ohms, 500 ohms, and 250 ohms. DC—0.01-0.75 volts.

BOLOMETER BIAS—Adjustable in steps of 2% current change over a range 2:1—metered directly.

POWER SUPPLY—115 volts 50/60 cycles 40 watts.

DIMENSIONS—19" wide, 8¾" high, 10" deep.

WEIGHT—27 lbs.

FINISH—Blue grey wrinkle panel and mahogany cabinet (unit may be rack mounted without cabinet if desired.)

Ask for Bulletin L-60

PICKARD & BURNS, INC.
240 Highland Avenue — Needham 94, Massachusetts

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 70A)

Beam-Power Amplifier Tube

A beam-power amplifier tube, designed for use in the audio output stage of television and radio receivers, has been added to the production lines of **Tube Divisions, General Electric Co.,** Syracuse, N. Y.

The new tube, Type 6W6-GT, is capable of delivering relatively large power output and features high sensitivity. When connected as a triode, the tube may be used as a vertical deflection amplifier in television receivers.

Maximum ratings of the tube include: peak positive pulse plate voltage, 1,000 volts; peak negative pulse grid #1 voltage, 200 volts; plate dissipation, 10 watts. The tube has a heater voltage (ac or dc) of 6.3 volts: heater current, 1.2 amperes.

Recent Catalog

• • • A copy of a new soldering gun catalog, fully illustrated, and featuring a new light duty model with dual spotlights is available from **Weller Electric Corp.,** 808 Packer St., Easton, Pa.

(Continued on page 74A)

Langevin
AMPLIFIERS
For broadcast, public address, recording, and music services — custom designs for special applications.

Langevin
TRANSFORMERS
Open-core, encased, hermetically sealed, high-temperature. Built to your own or MIL-T-27 specifications.

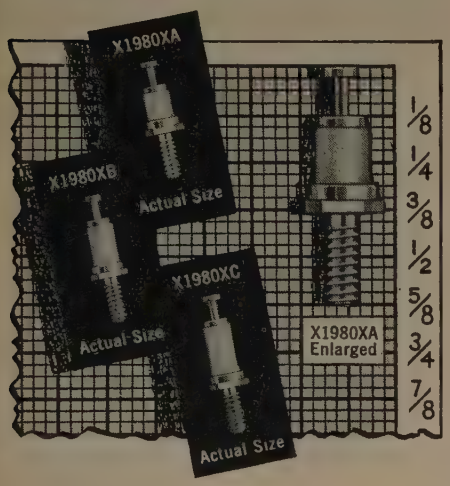
Langevin
ENGINEERING
Available for the development and manufacture of special electronic devices.

For detailed information on our products and services, write to

Langevin
MANUFACTURING CORPORATION
37 W. 65th St., New York 23, N. Y.

New Miniature Insulated Terminals

to help your miniaturization program



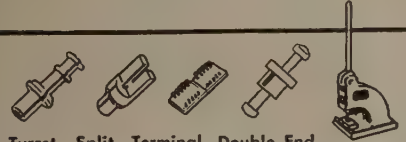
Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eighths of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .141" OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.



custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
456 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

UHF ENGINEERING

Specialized UHF knowledge, experience and shop techniques enable LAVOIE LABORATORIES, INC. to handle every phase of electronic production efficiently and economically.

•

Precision work and low unit cost are based on these factors developed through years of practical specialization in this field.

Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

Browning

INSTRUMENTS
Engineered for Engineers

SWEEP CALIBRATOR

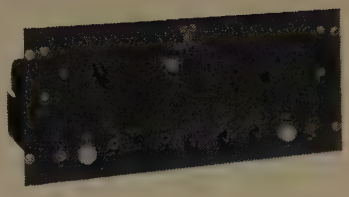
MODEL GL-22A

A versatile source of timing markers for accurate measurement of sweep intervals with oscilloscopes and synchroscopes.

- Positive or negative markers of 0.1, 1.0, 10, 100 micro-seconds variable to 50 volts.
- Variable width and amplitude gate for blanking or timing.
- Markers from external trigger or internal generator. May be synchronized with triggers up to 100 KC. repetition rate.
- Voltage regulation to timing circuits.

Write for free bulletin.

POWER SUPPLY



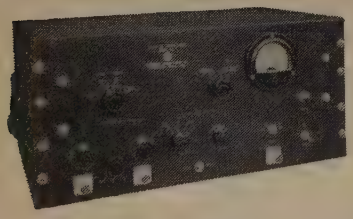
MODEL TVN-7

The basic unit of a microwave signal generator. Square-wave modulator for low-powered velocity-modulated tubes.

- Cathode voltage continuously variable 28-480 volts. Provision for 180-300 volt range.
- Reflector voltage range 15-50 volts.
- Provision for grid pulse modulation to 60 volts, reflector pulse modulation to 100 volts.
- Square-wave modulation variable from 600 to 2500 cycles.
- Provision for external modulation.

Write for free bulletin.

LABORATORY AMPLIFIER



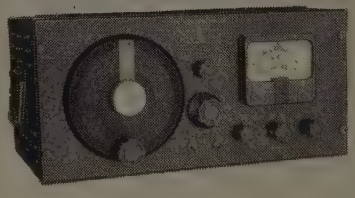
MODEL TAA-16

High gain audio amplifier feeding a-c volt-meter for measurement of standing wave ratios with slotted lines.

- 500-5000 cycles with broadband selective control on front panel.
- Sensitivity: Broadband 15-microvolts; selective 10 microvolts.
- Meter scales 0-10 and standing-wave voltage ratio.
- Panel switch for bolometer voltage application.
- Master gain control switch for attenuation factors of 1, 10, and 100.
- Stable electronic power supply.

Write for free bulletin.

FM MODULATION MONITOR



MODEL MD-25

For monitoring modulation of fixed or mobile FM transmitters in bands from 30-162 mc, to comply with FCC limitations of carrier frequency swing and reduce adjacent-channel interference.

- Coverage 30-40, 40-50, 72-76, 152-162 mc.
- Flasher indicates peak modulation (peak carrier deviation).
- Meter indicates peak swings of modulation to 1 kc.
- Sensitivity: signal measurements with approximately 1 millivolt at antenna input.

Write for free bulletin.

BROWNING
Laboratories, Inc.
Winchester, Mass.
ENGINEERED FOR ENGINEERS

In Canada, address
Measurement Engineering Ltd.
Arnprior, Ontario

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 72A)

Line Voltage Regulators

A new series of line adjusters has been added to the Stancor line of transformers, manufactured by **Standard Transformer Corp.**, 3580 N. Elston Ave., Chicago 18, Ill.

These four units permit operation of electrical devices at 115 volts when the supplied voltage is 65, 75, 90, 100, 115, 130, or 145. They meet power requirements up

(Continued on page 76A)

ALLISON RADAR

FOR

MULTI-ENGINED AIRCRAFT

Military • Airline • Executive

MODELS E ES ESB

58-65 LBS. OVERALL WEIGHT

1. Long range. 80-150 miles.
2. Exclusive scanning method.
3. Compact. Sturdy.
4. Easy to operate. Pilot control.
5. Simplicity of maintenance.
6. Gyro-stabilized.
7. JAN components.
8. RACON beacons.

•

ALLISON RADAR CORPORATION
11 West 42nd St., New York 18
PEnn 6-5811-12

EMSCO ENGINEERED RADIO TOWERS

For AM, FM, VHF, UHF, Microwave, Television and Radar

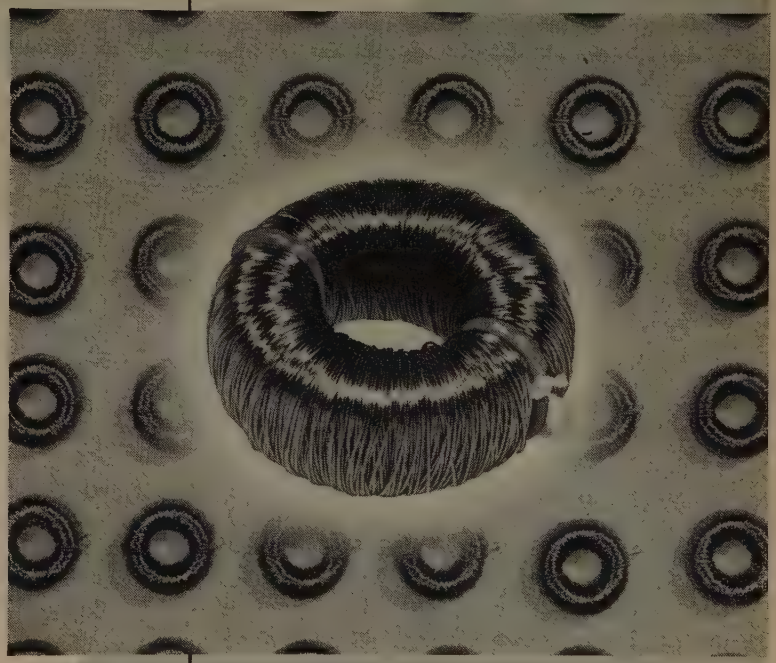
Emsco Towers are available for all types of broadcast and communication service. Backed by years of fabricating experience, Emsco towers are *engineered* for safety, performance and economy. Bolted construction and hot dip galvanizing insure long life, low maintenance cost and maximum electrical conductivity. Self-supporting triangular and square towers and guyed triangular towers are available in heights up to 1,000 feet with wind loadings up to 60 lbs. RMA design.

EMSCO
TOWERS OF EMSCO STRENGTH

There is an Emsco *Engineered* Tower to meet your needs. Write our Houston plant for bulletin.

EMSCO DERRICK & EQUIPMENT CO.
Houston, Texas • Garland, Texas
LOS ANGELES, CALIFORNIA

TOROIDS by B&W ...to your SPECIFICATIONS



Development of stabilized, high permeability cores of various types and grades, has greatly increased the applications of toroid coils in the low frequency range from 500 cycles to 200 KC. B&W toroids feature high inductance and high Q within a minimum of space and confined electrical field. These features assure the highest performance in many types of filters or networks.

Over fifteen years background in coil design and manufacture, plus the latest toroidal coil winding equipment, provides a combination that makes it possible for B&W to meet your most exacting requirements. B&W Toroidal Coils are available in open types, shielded, potted or hermetically sealed units in addition to complete filters or networks for specific applications. Our Engineering Department is ready to assist you with your problems in the application of toroids.

Write to
Dept. PR-120

BARKER & WILLIAMSON, INC.
237 Fairfield Avenue — Upper Darby, Pa.

Microwave "Shutter" by TERPENING

The "shutter" you see in the waveguide section above is designed to close automatically when the radar is not operating. This prevents damage to the crystal detector, which might be caused by radiation from other nearby radars.

Specifications called for very high attenuation when closed, extremely low attenuation when open, and fully automatic operation.

As designed and produced in quantity in our plant, the performance of this component exceeded our customer's expectations. For example:

with the solenoid-actuated shutter in closed position, attenuation is greater than 40 db,

with shutter open, attenuation is negligible—a few hundredths of one db.

This is a typical example of the work we are set up to handle—from design through production—from single component to entire transmission line. Although our engineering staff, laboratories, and fully equipped shop are usually busy on government contracts, our unusual facilities may permit us to work with you on special components for military microwave systems. We shall be happy to talk with you about your present and/or future needs.

L. H. TERPENING COMPANY

DESIGN • RESEARCH • PRODUCTION

Microwave Transmission Lines and Associated Components

16 West 61st St. • New York 23, N. Y. • Circle 6-4760

TRADE MARK

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 74A)

to 750 va, 50 to 60 cps. The line adjuster input is correctable in seven steps by means of a selector switch and indicated by an output voltmeter. These units are also useful for altering a 115-volt line above or below that level. They are equipped with a line cord and plug to fit a standard outlet and a plug-in receptacle to accommodate devices to be operated.

Vector Analyzer

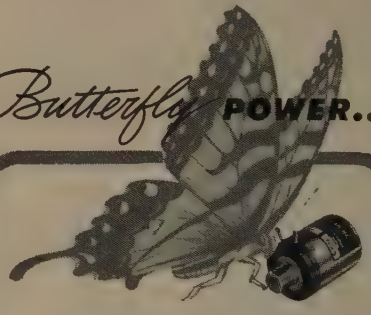
A new Vectrolyzer, Type 201, capable of measuring vector relations of alternating voltage from 8 cps to 500 Mc is announced by **Advance Electronics Co.**, P.O. Box 2515, Paterson, N. J.

The frequency range is 8 cps to 10 Mc through panel binding posts, 20 kc to 500 Mc through probe. Input Impedances: probe, 2.5 $\mu\mu$f shunted by 1/4 megohm and dielectric losses; binding posts, 14 $\mu\mu$f shunted by 100 megohms and dielectric losses.

The voltage range is 2, 4, 10, 20, and 40 volts, full scale. Phase angle range is 0°–180°, and 180°–360°, ranges with better angular sensitivity can be obtained through panel adjustment. Accuracy is ±3 per cent through panel binding posts, ±1 db through probe for phase angle measurements.

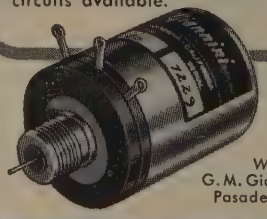
(Continued on page 78A)

Butterfly POWER...



• MICROTORQUE Variable Resistors and Potentiometers require as little as .003 in. oz. torque to operate. This unique feature makes the MICROTORQUE invaluable for applications where the position of instrument pointers, gyroscopes, and delicate instruments in general must be recorded, transmitted or indicated at a distance, and Giannini are the sole makers of MICROTORQUE Potentiometers.

A variety of resistance values and circuits available.



Write for booklet.
G. M. Giannini & Co., Inc.
Pasadena 1, California

giannini

for your

Raytheon Tube Requirements

in the

Metropolitan New York Area

It's

DALIS

Phone

Algonquin 5-3000

Serving the trade for over a quarter century

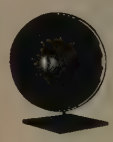
H.L. DALIS INC.

Wholesale Distributors Electronic Parts

175 VARICK ST., NEW YORK 14, N.Y.

Wire or Write Dept. IND

WORKSHOP



PARABOLIC ANTENNAS

Recent installations of Workshop Parabolic Antennas have replaced hundreds of telephone lines and several coaxial cables. Railroads, oil companies, and broadcast stations report remarkable savings in installation, operation, and maintenance costs.

The Workshop can supply parabolic antennas in a wide range of types, sizes, and focal lengths, plus a complete engineering service.

PARABOLAS — Precision-formed aluminum reflectors.

MOUNTINGS — Various types of aluminum reinforced mountings can be supplied with all antennas.

R. F. COMPONENTS — Precision machined and heavily silver plated. Critical elements protected by low-loss plastic radome.

PATTERN and IMPEDANCE DATA — A series of elaborate measurements of both pattern and impedance are made to adjust the settings for optimum performance.

POLARIZATION — Either vertical or horizontal polarization can be obtained easily by a simple adjustment at the rear of the reflector.

ENGINEERING and CONTRACT SERVICE — If your product or service requires high-frequency antennas, get in touch with the WORKSHOP. As the pioneer and acknowledged leader in this field, we can help you. Be it research, design, test, or production, our highly-skilled staff, backed by the finest laboratory equipment in the industry, can solve your antenna problem with a minimum of time and expense. Write, or phone Needham 3-0005. No obligation.

OTHER WORKSHOP ANTENNAS

Aeronautical Ground Station
For aircraft communications — omnidirectional.

Directional and Bi-Directional
For police, highway patrol, railway, forestry, utilities, oil fields.

Beacon
For fire, police, taxicab, and private fleet communications.

TV, FM and Amateur

The WORKSHOP ASSOCIATES, Inc.

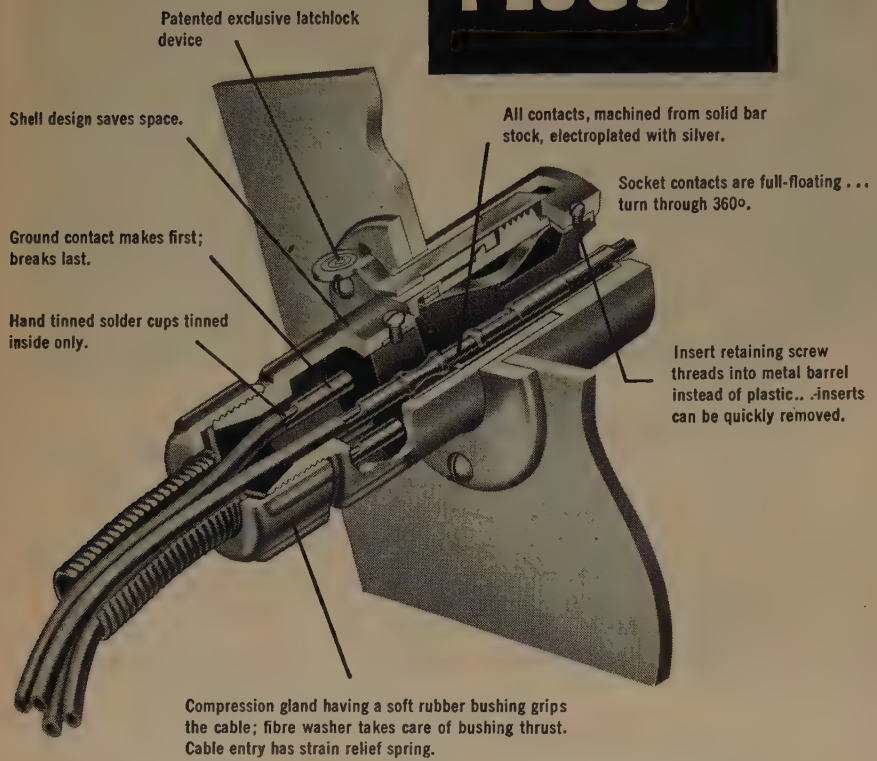
Specialists in High Frequency Antennas

135 Crescent Road, Needham Heights 94, Massachusetts

Here's why those in the know

–demand

CANNON PLUGS


Patented exclusive latchlock device
Shell design saves space.
All contacts, machined from solid bar stock, electroplated with silver.
Socket contacts are full-floating . . . turn through 360°.
Ground contact makes first; breaks last.
Hand tinned solder cups tinned inside only.
Insert retaining screw threads into metal barrel instead of plastic.. inserts can be quickly removed.
Compression gland having a soft rubber bushing grips the cable; fibre washer takes care of bushing thrust. Cable entry has strain relief spring.

No corners are cut . . . nothing is overlooked to assure you outstanding performance with Cannon Plugs. So long an engineer's choice, the words "Cannon Plugs" have become part of our electrical language. Continued excellence of design . . . ability to meet your changing requirements . . . are good reasons why the Cannon line of connectors continues to excel where specifications must be met. XL Connector Series is just one of the many Cannon types—world's most complete line. Request bulletins by required type or describe your needs.

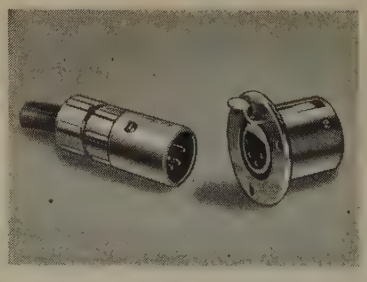
CANNON ELECTRIC

Since 1915

LOS ANGELES 31, CALIFORNIA

REPRESENTATIVES IN PRINCIPAL CITIES

In Canada & British Empire: Cannon Electric Co., Ltd., Toronto 13, Ontario. World Export (Excepting British Empire): Frazar & Hansen, 301 Clay St., San Francisco.



There are 12 items in the XL line. Insert arrangements available: 3—15 amp. contacts, 4—10 amp. contacts—working voltage 250 volts. Zinc and steel plugs with bright nickel finish are standard. Satin chrome finish also available on steel plugs.

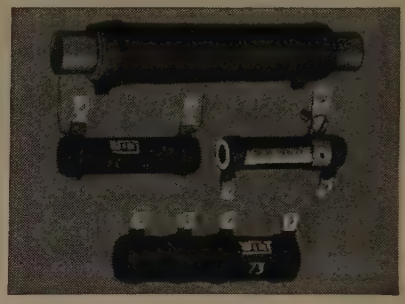
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 76A)

Improved Organic Coating for Resistors

An improved and thoroughly tested organic cement coating, trade named "Phenocote," materially adds to the shelf and service life of the line of resistors produced by **Wirt Co.**, 5221-27 Greene St., (Germantown) Philadelphia 44, Pa., manufacturers of components for the radio, electrical and electronic industries.



The new coating, when applied to resistor wire which is space wound on low-loss ceramic tubes, produces high stability for the resistance winding, and offers maximum protection against moisture,

(Continued on page 80A)

The New STAVER MINI-SHIELD

TRADE MARK REG. AND PAT. PEND.

The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5½ and T6½ bulb tubes. Send for catalog sheet.

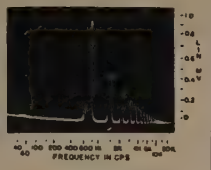
THE Staver COMPANY INCORPORATED

91 PEARL ST. • BROOKLYN 1, N. Y.
ULSTER 5-6303

***In only* 1 SECOND!**

COMPLETE AUDIO WAVEFORM ANALYSIS *with the* AP-1 PANORAMIC SONIC ANALYZER

Oscillograph of waveform to be analyzed →



Panoramic Sonic Analysis of the same wave

Provides the very utmost in speed, *simplicity* and *directness* of complex waveform analysis. In only one second the AP-1 *automatically* separates and measures the frequency and amplitude of wave components between 40 and 20,000 cps. Optimum frequency resolution is maintained throughout the entire frequency range. Measures components down to 0.1%.

- Direct Reading
- Logarithmic Frequency Scale
- Linear and Two Decade Log Voltage Scales
- Input voltage range 10,000,000:1

AP-1 is THE answer for practical investigations of waveforms which vary in a random manner or while operating or design constants are changed. If your problem is measurement of harmonics, high frequency vibration, noise, intermodulation, acoustics or other sonic phenomena, investigate the overall advantages offered by AP-1.

Write NOW for complete specifications, price and delivery.

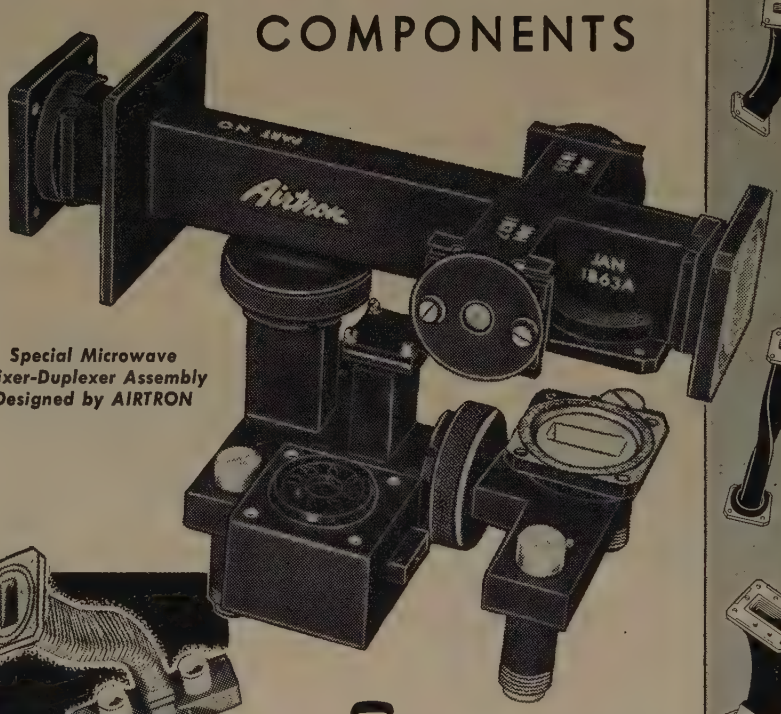
PANORAMIC RADIO PRODUCTS INC.
15 SOUTH SECOND AVE MOUNT VERNON N.Y.

Airtron DESIGNS AND PRODUCES

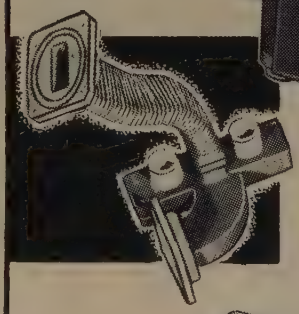
Flexible and *Rigid*

WAVEGUIDE

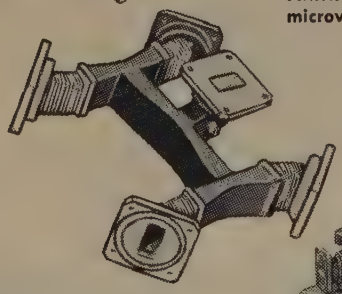
COMPONENTS



Special Microwave Mixer-Duplexer Assembly Designed by AIRTRON

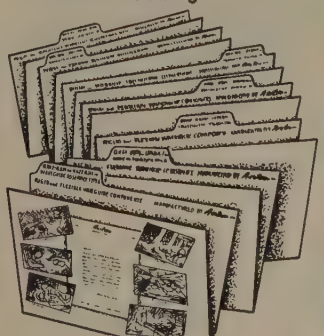


From the smallest waveguide component to complete transmission systems... from the first "doodle" memo or blueprint to the finished precision product . . . make AIRTRON your FIRST source for all types of microwave plumbing. Unique in background, technical savvy, plant facilities and the WILL to SERVE, this organization is prepared to engineer and manufacture your staple or special requirements in:



Mixers
Duplexer Assemblies
Magic Tees
Waveguide Switches
Elbow Bends
Elbow Miters
Twisted Sections
Rigid Twists
Choke Fittings
Flexible Waveguides
Straight Section
Rotary Joints

Send for AIRTRON Engineering Data on Microwave Plumbing



Airtron INC.
105 East Elizabeth Ave., Linden, New Jersey
BRANCH OFFICES
Baltimore Los Angeles New York
Boston St. Louis Dallas Dayton

Dependable
PERFORMANCE
at
LOWER COST

H&P
TOWER LIGHTING EQUIPMENT

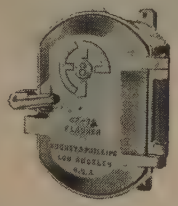
H & P lighting equipment, consistently specified by outstanding radio engineers, is furnished as standard equipment by most leading tower manufacturers.

300 MM CODE BEACON

Patented ventilator dome circulates the air, assures cooler operation, longer lamp life. Concave base with drainage port at lowest point Glass-to-glass color screen supports virtually eliminate color screen breakage. Neoprene gaskets throughout. CAA approved

MERCURY CODE FLASHER

Lifetime-lubricated ball bearings. No contact points to wear out. Highest quality bronze gears Adjustable, 14 to 52 flashes per minute



SINGLE and DOUBLE OBSTRUCTION LIGHTS

Designed for standard A-21 traffic signal lamps Prismatic globes meet CAA specifications.

"PECA" SERIES PHOTO-ELECTRIC CONTROL

Turns lights on at 35 f.c.; off at 58 f.c., as recommended by CAA. High-wattage industrial type resistors. Low-loss circuit insulation

ALSO COMPLETE LIGHT KITS FOR A-2, A-3, A-4 and A-5 TOWERS

PROMPT SERVICE and DELIVERY

First-day shipments out of stock. Immediate attention to specifications and unusual requirements

WRITE OR WIRE FOR CATALOG AND DETAILED INFORMATION

HUGHEY & PHILLIPS
TOWER LIGHTING DIVISION
326 N. LA CIENEGA BLVD.
LOS ANGELES 48, CALIF.
60 E. 42ND ST. NEW YORK 17, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 78A)

humidity, and electrolysis. Inert chemically, it will not affect the most delicate windings; however, it is recommended for both fine and larger wire sizes. The improved coating may be applied to fixed-variable, ferrule, and Edison base styles of resistors.

Intermodulation Meter

Measurements Corp., Intervale Rd., Boonton, N. J., announces the development of a completely self-contained intermodulation meter.

This new laboratory standard, Model 31, consists of two principal sections, a test signal generator and an analyzer. The generator section produces two sinusoidal voltages, one of low frequency and the other a high frequency, which are mixed in a 4/1 voltage ratio and applied to the apparatus under test.

The signal is then received by the analyzer section, where it is filtered, amplified, demodulated, and metered. The meter is direct-reading in percentage of intermodulation and input volts.

This instrument is useful for evaluating the performance of audio systems, for the adjustment and maintenance of AM and FM receivers and transmitters; for checking linearity of film and disk recordings and reproductions, for checking phonograph pickups and recording styli, for adjusting bias in tape recordings, for quality control of all audio components and equipment, and for many other applications.

Bolometer Bridge

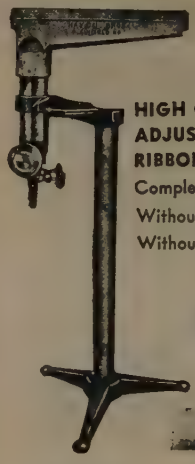
The General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., recently developed the Type 1651-A bolometer

bridge for maximum flexibility in application, so that it can be adapted to a variety

(Continued on page 81A)

GREATER PRODUCTION
with Haydu burner equipment!

HOT SHOT BOMBARDER
7½ KVA $130.35

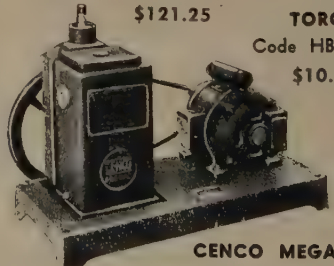


HIGH COMBUSTION ADJUSTABLE RIBBON BURNER
Complete as illustrated, 16" $77.75
Without Floor Base $57.75
Without Floor Base and Economizer $47.75

CROSSFIRES
Code CF—$29.95
5-way with mixer.

AIR PRESSURE BLOWER No. 24
With base and ½ HP motor..... $171.55
Less motor and base $121.25

TORCH
Code HB-81
$10.75



CENCO MEGAVAC PUMP
With base and ½ HP motor...$198.00

Increase job capacity, job quality, and profit margins for your glass business through modern, laboratory-tested Haydu products!

Everything for the Neon Industry
HAYDU BROTHERS
Plainfield, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 80A)

of power measurement problems. It can be used, not only with **General Radio** bolometers, but also with those of other manufacture having resistances between 25 and 400 ohms. Measurements can be made either by a direct-reading or a substitution method. Current range is 0 to 100 ma; power range is 0 to 500 milliwatts.

Matching transformers and other accessory equipment can be assembled from General Radio Type 874 coaxial elements.

Plant Expansion

The General Electric Co., Schenectady, N. Y., has announced that it will reopen its Clyde, N. Y., plant and transfer the production of germanium products now made at the GE, Thompson Rd. plant in Syracuse to the Clyde factory.

W. R. G. Baker, company vice-president and general manager of the GE Electronics Dept., said the transfer is being made because of expanded production requirements for these products, and also to make room for increasing government business at the Syracuse plants.

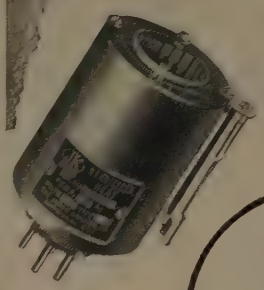
(Continued on page 82A)

CRYSTALS FOR THE CRITICAL

It's a sure bet that once you've used a JK stabilized crystal, you'll be back for more.

Their dependability has earned them preference across the nation with electronics manufacturers everywhere.

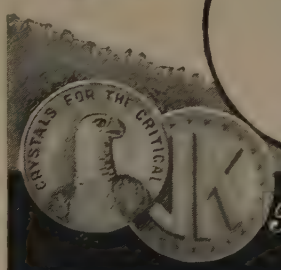
What's more, there's a JK crystal to fit every need—available at modest cost in single units or in production quantities.



BROADCAST STABILIZED UNIT—JK57MT

The new JK57MT has frequency range from 400 kc to 1750 kc. Nominal temperature 60°C ±1°. Adjustable frequency ±.01%, so it can be put on exact frequency in your equipment. 6.3 volt 1.5 amp. heater. Completely insulated, will hold temperature to —20°C. Can be supplied with octal base (JK87MT) with or without thermometer, and set for various temperatures.

This new crystal features a unique and more positive method of varying the gap. Unlike conventional crystals, in which the entire electrode turns to change the frequency, the JK57MT variable electrode only moves up and down in guides like a piston. This completely eliminates any danger of damaging the crystal.



The James Knights Company
SANDWICH, ILLINOIS

TWIN LEAD, TELEVISION
LIGHTNING ARRESTER

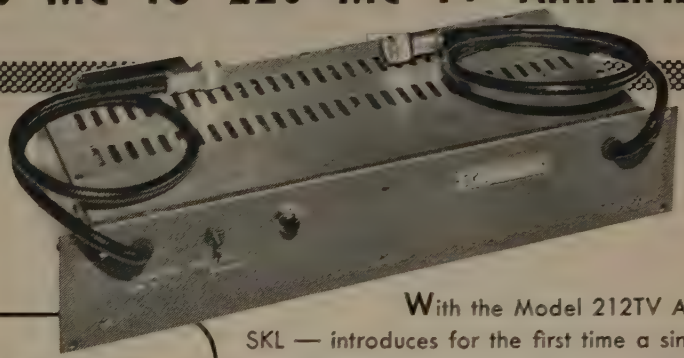
APPROVED for OUTDOOR-INDOOR Use
Protects Television Sets Against Lightning and Static Charges
$2.25
Twin Lead
JFD SAFE TV GUARD

Simple to install everywhere and anywhere ...no stripping, cutting or spreading of wires. More than 300,000 in use today!

SEE YOUR JOBBER OR WRITE TO

JFD MANUFACTURING CO., Inc.
6127 16th Avenue, Brooklyn 4, N. Y.
First in Television Antennas & Accessories

40 MC TO 220 MC TV AMPLIFIERS



SPECIFICATIONS

- BANDWIDTH 40 MC — 220 MC
- IMPEDANCE 52, 72, and 93 ohm unbalanced, 300 ohm balanced
- GAIN ..... 20 db
- OUTPUT VOLTAGE 4 volts RMS Maximum
- RESPONSE ± 2 db over bandwidth
- PRICE $200.00 f.o.b. Cambridge, Mass.

With the Model 212TV Amplifier—SKL — introduces for the first time a single broad band booster capable of amplifying all 13 television channels simultaneously. Because of its stability and reliability — a tube failure means only a slight loss of gain, not amplifier failure — the Model 212TV Amplifier can be safely left unattended for long periods of time. Its low noise level, high output, and low impedance make the Model 212TV Amplifier ideal for television distribution systems in hotels, apartment houses, sales rooms and television stations and manufacturers' plants.

Write today for further information

SKL SPENCER KENNEDY LABORATORIES, INC.
186 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

How Technical Books Are Bought

By Harry C. Waterston

Mr. Waterston is president of Waterston & Fried, Inc., an advertising firm which handles such accounts as Wiley, Reinhold, and Cornell Maritime press, technical and trade journal publishers.

Have you ever thought about the book buying habits of the scientist or technician? Does he generally buy his books from a bookstore or through an advertisement in a professional journal? Is he influenced more by book reviews than by personal recommendations in his selection of books?

The factors that influence book buying in the technical and scientific fields have been of great interest to us. Often we have asked technically-trained friends and acquaintances how and where they bought books. We have checked with publishers whose accounts we handled, for their experiences and opinions. However, we found many divergent theories among publishers as to how technical books are bought.

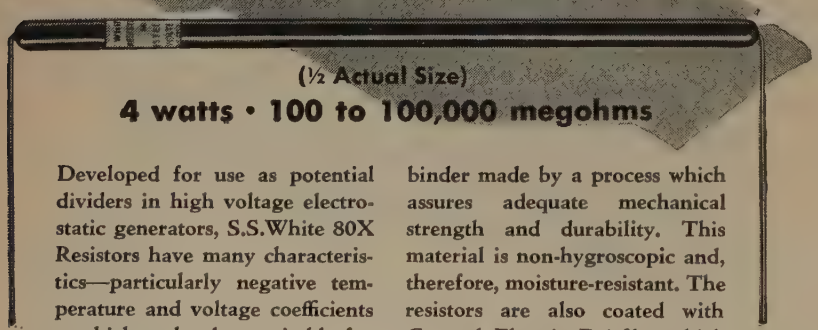
Our interest in this subject stems from the fact that for almost a decade we have been preparing advertising for books written for special audiences. Chemistry, music, business, medicine, aeronautics, art, radio electronics and many other subjects are included in the list of titles we have promoted.

Recently, we were discussing with William Copp, advertising manager of the PROCEEDINGS OF I.R.E., the need for factual information on what influenced people to buy technical books. We both agreed that a survey should be made to secure this important information.

Mr. Copp told us that he and the Institute of Radio Engineers would be glad to finance such a survey, and he suggested that our company conduct it. We were delighted to offer our name and facilities to such a worthwhile cause.

We decided to select 1,000 readers of the PROCEEDINGS OF I.R.E. From the list of subscribers we chose the first forty names of each letter of the alphabet. *(Continued at Right)*

The new S.S.WHITE 80X HIGH VOLTAGE RESISTOR



(½ Actual Size)

4 watts • 100 to 100,000 megohms

Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage coefficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture-resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

WRITE FOR BULLETIN 4906

It gives complete information on S.S.White resistors. A free copy and price list will be sent on request.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. G-R 10 East 40th St.
NEW YORK 16, N. Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from left)

HOW TECHNICAL BOOKS ARE BOUGHT

The questionnaire was mailed on our firm's letterhead. In introducing the subject, we said, "One of our mutual friends in radio and electronics has asked us to obtain some information on the book interests and buying habits of leading radio engineers."

Of the 1,000 questionnaires mailed, 17 were returned undelivered, 290 subscribers, or 29% of the balance, returned the form with the answers filled in. Replies came from Canada, Colombia, France, Israel, Venezuela, Cuba, India, Sweden and Hawaii, as well as from all parts of the United States.

The first question was, "*Approximately how many technical and scientific books do you buy in a year?*" Several replied that they bought as many as 40 to 50 books. One said that he bought $100 worth, but the average was more modest. Here is the tally:

1 to 5 books	59%
6 to 10 books	29%
More than 10 books	12%

"*What is your usual method of purchasing these books?*" was the next question. Here we listed four choices and an "*Other*" for those who purchase their books in an unusual manner.

Buy books from bookstores	52%
Through purchasing agent or other person in own organization	28%
Clip coupon from ads	9%
Write or phone publisher	47%
Other: School and engineering societies, distributors of radio parts, desk copies, etc.	3%

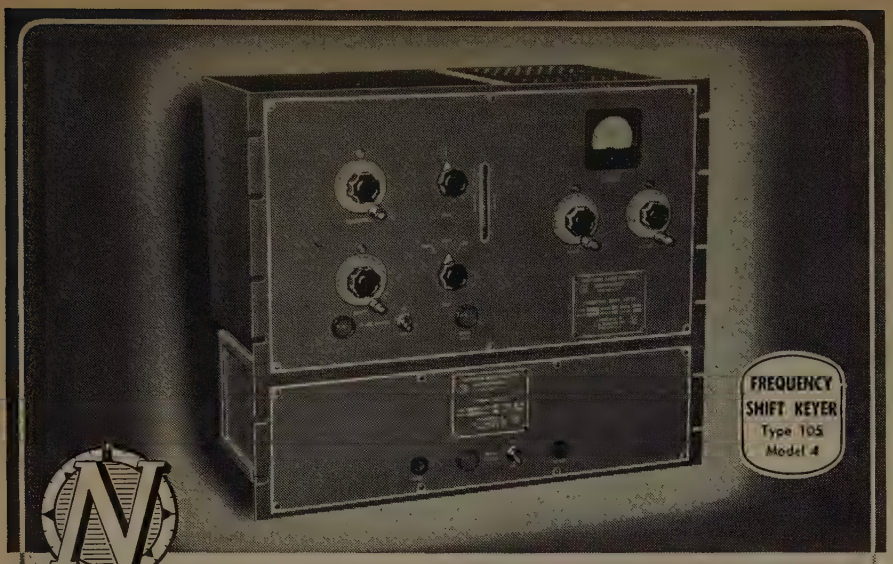
Many checked more than one method of purchasing books.

"*What guides you in the selection of technical books?*" Four choices and an "*Other*" were listed here.

Due to a clerical error, "publisher's literature" was omitted from the questionnaire. However, the opportunity for a "write-in" vote was available to any subscriber under "*Other*" guides to selection. Fortunately, every book publisher has exact figures on the selling ability of direct mail literature. Notwithstanding this omission, we believe the statements made by those participating in this survey still give us a clear picture as to what influences them in the selection of technical titles.

Personal recommendation by associates in the field	64%
Book reviews in technical magazines	66%
Recommendation of book salesman	2%
Advertisements for books in technical magazines	37%

(Continued on page 84A)



HIGHEST STABILITY in Quality Communications

In today's high-speed telegraph, teleprinter and multi-channel radio communication systems—more than ever before—utmost stability is a vital need. Northern Radio's *exclusive* answer is the Type 105 Model 4 FREQUENCY SHIFT KEYER. Its highly stable oven has a temperature control of ±0.1° C at 60°, with heaters on 4 sides of the inner oven—giving this unit frequency stability unmatched in the industry. And, greatest ease of operation is assured by its completely direct-reading dials.

See the specifications on this outstanding model in the 1950 IRE Directory. For complete data on the precision-built Northern Radio line, write today for your free latest Catalog P-1.

NORTHERN RADIO COMPANY, inc. • 143-145 West 22nd Street • New York 11, N. Y.

Pace-Setters in Quality Communication Equipment

INCREASED ACCURACY

- *SWEEPS .01 sec/cm to .1 μsec/cm Accuracy 5% or greater.*
- *.04 μsec RISE TIME*
- *FULLY REGULATED POWER SUPPLY.*
- *VOLTAGE CALIBRATOR 5% Full Scale Accuracy.*

TEKTRONIX TYPE 511 AD OSCILLOSCOPE
Price $845.00 f. o. b. Factory

Increased accuracy in sweep time calibration is made possible by the use of dual Sweep Multiplier dials. The 2 megohm variable carbon resistor formerly used has been replaced by a combination of 1% fixed resistors and a variable element which comprises only 10% of the total.
Electronic regulation of all DC voltages preserves the inherent accuracy regardless of severe line voltage variations.

Write for further information on the Type 511 AD and other Tektronix instruments.

TEKTRONIX, INC.

712 S.E. Hawthorne Blvd. Portland 14, Ore.

The ONE and ONLY!

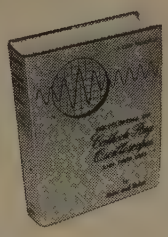
Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses

by John F. Rider and Seymour D. Uslan

ANSWERING THOUSANDS OF VITAL QUESTIONS CONCERNING OSCILLOSCOPES

More than two years were devoted to the writing, checking, editing, and compiling of this cross section of knowledge on cathode-ray oscilloscopes, theory and applications, embracing all fields of activity.

It is the **FIRST** and **ONLY** book available to the engineering fraternity which offers complete coverage of the oscilloscope as a laboratory facility.



CONTENTS

1—Introduction; 2—Principles of electrostatic Deflection and Focusing; 3—Principles of Electromagnetic Deflection and Focusing; 4—Mechanical Characteristics; 5—The Electron Gun; 6—Deflection Systems; 7—Screens; 8—Spot Displacement; 9—Linear Time Bases (Sweep Circuits); 10—The Basic Oscilloscope and Its Modifications; 11—Synchronization; 12—Phase and Frequency Measurements; 13—Nonlinear Time Bases; 14—Auxiliary Equipment; 15—Testing Audio Frequency Circuits; 16—Visual Alignment of AM, FM, and TV Receivers; 17—Waveform Observation in Television Receivers; 18—AM, FM, and TV Transmitter Testing; 19—Electrical Measurements and Scientific and Engineering Applications; 20—Complex Waveform Patterns; 21—Special Purpose Cathode-Ray Tubes; 22—Commercial Oscilloscopes and Related Equipment; Appendix I—Characteristics of Cathode-Ray Tubes; Appendix II—Cathode-Ray Tube Basing; Appendix III—Photography. Bibliography.

Planned and written to serve all fields, it is of inestimable value to persons in all forms of research; electrical, medical, industrial, geophysical, atomic—civilian and military—for visual analyses of all electric and magnetic phenomena, and many nonelectrical actions such as vibration, pressure, rotary motion, heat, light, etc. . . .

An outstanding feature of this book is a most useful and comprehensive compilation of 1600 complex waveform patterns listing the harmonics and the exact phase and amplitude of each. This information has **NEVER BEFORE BEEN PUBLISHED!** All 'scopes produced during the past 10 years, a total of more than 70 different models, are clearly described—with specifications and schematic wiring diagrams.

Appendixes on the characteristics of Cathode-Ray Tubes, RMA Cathode-Ray Tube Basing Charts, and Cathode-Ray Photography; with an extensive Bibliography furnishing additional sources of related information.

992 Pages • 500,000 Words • 3,000 Illustrations
22 Chapters • Completely Indexed • 8½ x 11" Size • Easy to Read • Cloth Bound.

Weighing 5½ lbs., this book is the most valuable, information-packed reference for engineers, geophysicists, technicians, manufacturers, teachers, libraries, Armed Forces schools and laboratories, college laboratories, research laboratories, etc..... **Only $9.00**

10-DAY MONEY-BACK GUARANTEE

Make this book PROVE its value! Unless you agree that it is everything we claim it to be—return the book, in good condition, for refund.

Rush This Coupon Today

JOHN F. RIDER PUBLISHER, INC.
480 Canal Street, New York 13, N.Y.

Please send me your "ENCYCLOPEDIA ON CATHODE-RAY OSCILLOSCOPES AND THEIR USES" on your 10-day MONEY-BACK GUARANTEE. If not satisfied, I will return the book, in good condition, for refund.

Name.....

Address.....

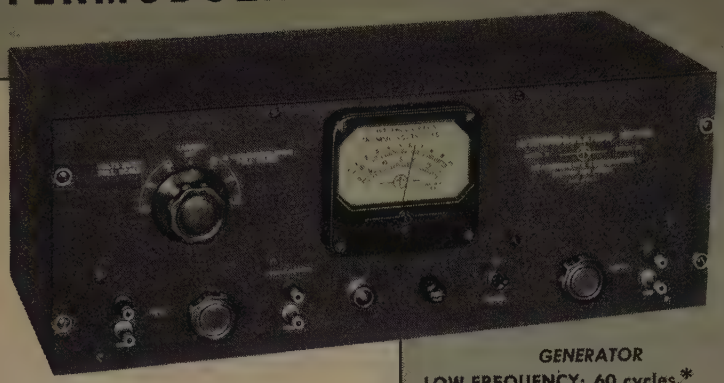
City.....Zone.....State.....

SAVE POSTAGE. If you enclose check or money-order WITH coupon, we will prepay postage charges. Money back if you return the book within 10 days.

☐ Check Encl. ☐ Money-Order Encl. ☐ C.O.D.

13

INTERMODULATION METER *Model 31*



- *Completely Self-Contained*
- *Direct Reading For Rapid, Accurate Measurements*

To insure peak performance from all audio systems; for correct adjustment and maintenance of AM and FM receivers and transmitters; checking linearity of film and disc recordings and reproductions; checking phonograph pickups and recording styli; checking record matrices; adjusting bias in tape recordings, etc.

GENERATOR

LOW FREQUENCY: 60 cycles.*
HIGH FREQUENCY: 3000 cycles.*
LF/HF VOLTAGE RATIO: Fixed 4/1.
OUTPUT VOLTAGE: 10v. max. into high impedance or +5 DBM matched to 600 ohms.
OUTPUT IMPEDANCE: 2000 ohms.
RESIDUAL IM: 0.2% max.
(*Other frequencies on special order)

ANALYZER

INPUT VOLTAGE: Full scale ranges of 3, 10 and 30 volts RMS. Less than one volt of mixed signal is sufficient for operation.
INPUT IMPEDANCE: Greater than 400 K ohms.
INTERMODULATION: Full scale ranges of 3, 10 and 30%.
ACCURACY: ±10% of full scale.
OSCILLOSCOPE connection at meter.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

TELECHROME
ANNOUNCES A NEW LINE

- COLOR AND MONOCHROME PICTURE GENERATORS
- COLOR SYNC GENERATORS
- COLOR MONITORS
- COMPLETE STUDIO TYPE COLOR EQUIPMENT FOR DOT, LINE OR FIELD INTERLACE SYSTEMS BUILT TO YOUR SPECIFICATIONS

TELECHROME
INCORPORATED
295 W. SHORE DR., MASSAPEQUA, N.Y.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 82A)

Publisher's literature..... (Written in under "*Other.*" See preceding paragraph.)	15%
Other (Personal perusal, library, bookstore, publisher's showroom, borrow book, knowledge of author.....	15%

Here, too, more than one classification was checked by most participants.

It is interesting to note that, while 52% purchase books from bookstores, only 2% say they are influenced by the recommendations of a book salesman. It is obvious, therefore, that the technical book buyer must be sold on a book—its subject matter, its advantages to him in his field, the name and authority of the author, and its publisher—*before* he walks into a bookstore.

Another interesting point is that while 37% admit that they are influenced by book advertisements in technical publications, only one-fourth of these actually clip coupons from ads to purchase books.

We also thought it would be a good idea for technical people to express their preference for book publishers in their field. This question was asked:

"*What book publishers do you consider publish the best books in your field?*" No check-list was supplied here. Each person wrote the names of the publishers he thought best. A total of thirty-seven publishers was named. The leaders were:

McGraw-Hill.....	84%
John Wiley & Sons.....	61%
Van Nostrand.....	30%
Dover.....	6%
Prentice-Hall.....	5%
Macmillan.....	5%
Cambridge University.....	3%
Oxford University.....	2%

No questionnaire is complete without some space for "*Special Remarks.*" So we provided space for free expression for those who were good enough to take the trouble to fill out the form. The following are a typical "cross-section" of the comments we received.

A Canadian commented:

"Textbooks are very expensive in Britain. American books are prohibitive now on devalued Sterling."

A Cambridge, Mass. subscriber offered this suggestion:

"Eliminate elementary review material from many books and thereby reduce the price, which is generally too high."

A Brooklyn, N. Y. member observed:

"Most books in the field tend to start with too few assumptions about the knowledge of the reader. Elementary material should be confined to strictly elementary texts. This is a policy that all publishers should follow more consistently than they do."

(Continued on page 85A)

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 84A)

From Buffalo, N. Y. (after mentioning the three leaders):

"Other technical publishers are apparently too proud to push their wares."

From Dallas, Texas:

"Would undoubtedly buy more technical books were it possible to 'look them over' locally . . . publishers are selling their market short—scientific men must be by nature and necessity eager for books, and reduced prices should reap a large increase in sales volume."

A Naval Commander in Portsmouth, Va.:

"Electronics books should be published in cheaper (possibly paper) editions. Considering their high rate of obsolescence they cost too darn much!"

East Chicago, Ill. contributed:

"A book prepared by a single author of outstanding reputation in his field is superior to one produced through a collaboration of many authors."

From Old Saybrook, Conn.,

"Would like to see more books on the Philosophy and Nature of Scientific Theory to arouse interest in fundamental research in this country."

A Challenge from Pasadena, Cal.:

"There ought to be a more effective way of bringing books to the attention of scientific people than methods now in use."

This St. Paul, Minn. subscriber was very critical:

"I find that manufacturers' data is generally as complete and cheaper—too many books carry the same material."

A Cynic from Pittsburgh, Pa. cried:

"What best books? Most are revisions of revisions."

An Advertising-conscious New Yorker wrote:

"Advertisements undoubtedly have an unconscious effect in my purchases of technical literature."

Improved Flexible Electrical Conduit

An improved flexible electrical conduit has been devised by Elliott Solero, of **National Electric Products, Corp.**, P.O. Box 897, Pittsburgh 30, Pa.

The conduit consists of an inner woven tubing made of longitudinal *Fiberglas* yarns, and a spiral wrapping of metal foil, with an outer braided jacket of aluminum wire. Conventional construction makes use of a spiral armor of interlocked aluminum strip over a braided aluminum wire jacket.

Using less metal than the conventional type, the new conduit is lighter, has greater flexibility, affords more uniform shielding and provides better resistance to damage from moisture, flame, oil spray and fungus.

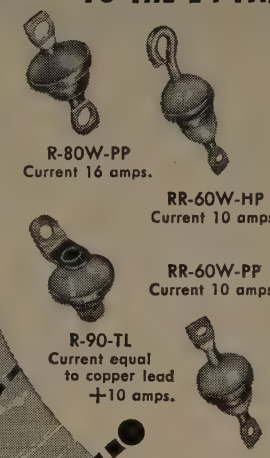
The new flexible conduit is expected to find wide usage in applications involving high-frequency currents—notably in aircraft radar equipment, automotive radio insulation, etc.

(Continued on page 86A)

E-I HERMETIC SEALING COMPONENTS

Announcing: AN IMPORTANT ADDITION TO THE E-I FAMILY OF SEALED LEADS—

NEW R and RR SERIES TERMINALS



A completely new line of double barrel terminals that provide added protection against flashover without any appreciable increase in terminal size. The double barrel results in a longer leakage path on both ends of the terminal while the upper barrel increases the mechanical strength of the terminal and facilitates soldering. For information call or write today.

Write for These Descriptive Bulletins:

849—Hermetically Sealed Terminals
850—Hermetically Sealed Headers
851—Gasket Type Bushings

E-I INC ELECTRICAL INDUSTRIES INCORPORATED
44 SUMMER AVENUE NEWARK 4, N. J.

Only with CO-AX air-spaced articulated R.F. CABLES

Patents Regd. Trade Mark.

THE LOWEST EVER CAPACITANCE OR ATTENUATION

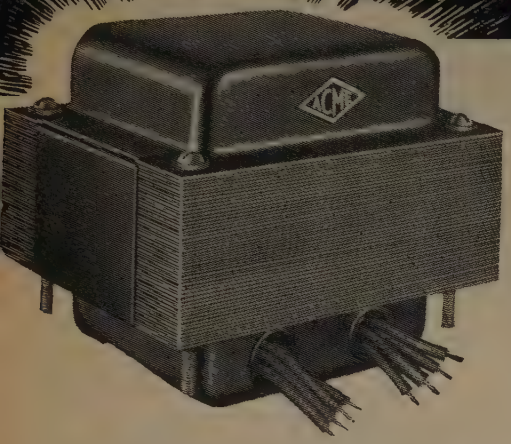
We are specially organised to give SPOT DELIVERIES TO U.S.A *Cable your rush order for shipment by air freight. Settlement by your own $ check*

LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft of 100 Mc/s.	LOADING Kw	O.D."	
A 1	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	HIGH POWER FLEXIBLE
A 34	73	0.6	1.5	0.88	
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C 22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C 33	4.8	220	2.4	0.64	V.L.C. ★
C 44	4.1	252	2.1	1.03	

★ *Very Low Capacitance cable.*

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD · LONDON SW7 ENGLAND
CABLES: TRANSRAD, LONDON.

FOR BETTER PERFORMANCE
BETTER BUY
Acme ACME Electric
TRANSFORMERS



You write the specifications and Acme engineers will design a transformer with the exact output characteristics to provide "top" performance for your product. And remember, in addition to quality performance, Acme also can provide quantity production in custom designed electronic transformers.

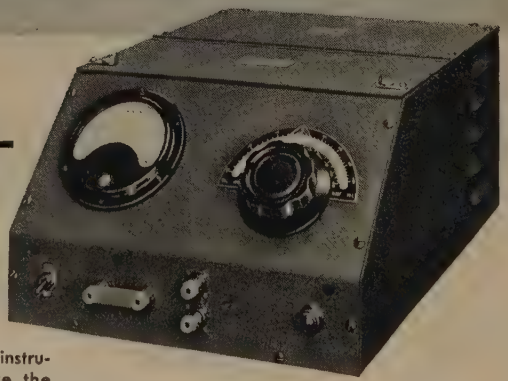
ACME ELECTRIC CORPORATION • 4412 Water St., Cuba, N.Y., U.S.A.

Acme ACME Electric
TRANSFORMERS

CHECK small inductors

...Quickly and Accurately—

with this TYPE 110-B
QX-CHECKER



The QX-Checker is a production type test instrument specifically designed to compare the reactance and relative Q of small RF inductors with approved standards. The two factors, reactance and relative Q, are separately indicated, one on the meter and the other on a condenser dial, so that the deviation of either from established tolerances is immediately shown. Built to laboratory standards, the QX-Checker is a sturdy, foolproof instrument for use in production work by factory personnel.

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 1.5 to 25 mc. in 3 ranges using accessory plug-in-coils (two coils furnished with each instrument).

ACCURACY OF COIL CHECKS: Inductance values between 5 and 35 microhenries may be checked to an accuracy of ±0.5%. Smaller values down to 0.1 microhenries may be checked with decreasing accuracy.

INDICATING SYSTEM: Q indicating meter with well expanded 3¼" scale shows departure of Q from nominal value. Vernier condenser scale calibrated directly in terms of percent departure from known standard over range of —15% to +20%. Capacitance scale is also provided reading changes of —50 mmf. to +50 mmf. from nominal circuit capacitance of 300 mmf.

POWER SUPPLY: 110-125 volts, 50-60 cycles, also 200-250 volts, 50 cycles.

DIMENSIONS: Width 12¼", Depth 18", Height 8".

WEIGHT: 26 lbs. PRICE: $415.00 f.o.b. Boonton, N. J.

A limited supply of these instruments available from stock.

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 85A)

New Small Coupler

A new Micromatch, Model 570, series designed as a transmitter component to continually monitor rf power output, vswr, and sidetone is being produced by **M. C. Jones Electronics Co.**, 96 Main St., Bristol, Conn.

Model 570 has a frequency range of 20 to 2,000 Mc., and an impedance of 51 ohms. It is supplied with RG-9/uc cable, or female N type connector which accepts UG-21/U connector attached to RG-9/U cable.

Meter scale reads 0 to infinity: A vswr of 3.0 corresponds to approximately half scale deflection.

Audio frequency output available for monitoring when used with an AM transmitter.

(Continued on page 87A)

don't fail to see the

AMPEREX TUBE

advertisement next month
(January issue)
on the inside front cover

AMPEREX ELECTRONIC CORP.
25 WASHINGTON STREET, BROOKLYN 1, N. Y.
In Canada and Newfoundland: Rogers Majestic Limited
11-19 Brentcliffe Road, Leaside, Toronto, Ontario, Canada
AMPEREX

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 86A)

Frequency Standard

The new Type 2005, frequency standard, with an output frequency of 60 cps accurate to 1 part in 100,000 in temperature range from 0 to 60° C, has been designed by **American Time Products, Inc.**, 580 Fifth Ave., New York 19, N. Y.

Output power is 10 watts, 115 volts approximate sine wave. The input is 115 volts, 50 to 400 cps 45 watts.

(Continued on page 88A)

Compare for *results!*

Compare for *price!*

and you will choose the GREEN ENGRAVER

The Green Engraver offers great speed and convenience. Quickly cuts up to four lines of letters from 3/64" to 1" on curved or flat surfaces whether made of metal, plastics or wood . . . operates by merely tracing master copy — *anyone* can do an expert job. Special attachments and engineering service available for production work. Just the thing for radio, electronic apparatus and instrument manufacturers.

For *quality* engraving on

• Panels • Name Plates • Scales • Dials • Molds • Lenses • Instruments . . . also does routing, profiling and three dimensional modeling.

GREEN INSTRUMENT CO.

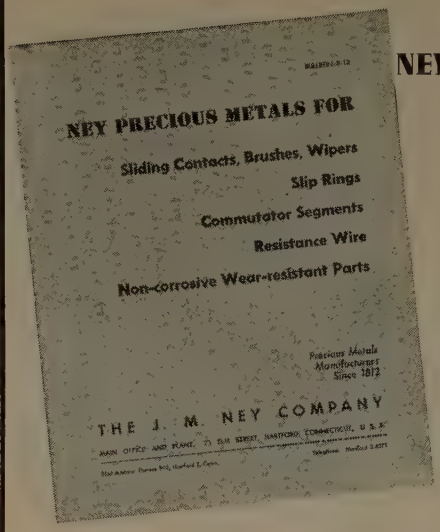
GREEN 361 Putnam Ave Cambridge, Mass.

. . . Now available

for the first time . . . in convenient reference form comprehensive technical, test and application data on

NEY PRECIOUS METAL ALLOYS

for sliding contacts, slip rings and non-corrosive, wear-resistant parts



SEND FOR THIS USEFUL DATA BOOK

This catalog contains the boiled-down results of more than ten years' work in the solution of special contact and bearing problems in the electrical, electronic and scientific instrument fields. In addition to outlining the characteristics, applications and physical properties of Ney Precious Metal alloys, photographs and dimension drawings of a wide range of contacts, wipers and brushes now available as standard production items are also included. Engineers and designers are invited to write for copies of this useful data book, Bulletin R-12. We also offer the Ney Research Department's important reservoir of practical experience in this field for work on new or special applications.

THE J. M. NEY COMPANY

171 ELM STREET, HARTFORD, CONN.

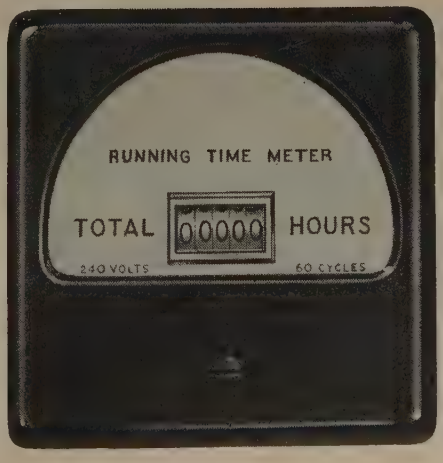
SPECIALISTS IN PRECIOUS METAL METALLURGY SINCE 1812

18NY50

Another PRECISION PRODUCT

Burlington

RUNNING TIME METER



• 9999.9 hour range
• 10,000 hour automatic reset
• —55 to +55° C. operating temperature.

• Designed for use on AC lines where successful servicing of electronic or electrical equipment depends upon the regular servicing of such equipment based on actual operating (or idle) time. Unit has a range of 9999.9 hours and resets automatically at 10,000 hours. Can be supplied for either 120 or 240 volts. 60 cycle operation and has operating temperature of —55 to +55° C.

• The Running Time Meter is housed in Burlington's attractive, black bakelite 3" square or 3½" round case.

Write Dept. I. 120 for further details.

BURLINGTON INSTRUMENT COMPANY

BURLINGTON, IOWA

COSSOR for QUALITY

TWIN BEAM OSCILLOSCOPES

independent amplifiers for each beam—no electronic switching.

YOU can use COSSOR TWIN BEAM SCOPES in *your* work! Here are a few reports of the innumerable applications now possible . . .

Cement Research Lab measures sound velocity in concrete with Model 1035 by measuring delay between transmitted and reflected sonic pulses.

Transformer Manufacturer uses 1035 to measure winding unbalance by simultaneous comparison of voltages on two phases.

Manufacturer of radar video stages uses 1035 to compare input and output waves for gain, phase shift and distortion.

Boxcar manufacturer sets up phase shift controls in spot welder with 1049.

Audio amplifier manufacturer uses 1049 to balance push-pull circuits.

MODEL 1049

Use Model 1035 for fast sweeps, HF amplifier applications.
Use Model 1049 for slow sweeps, twin DC amplifier work.
Use Model 1428 Camera for still or moving film recording.

Write today for details and demonstration!

COSSOR (CANADA) LIMITED
301-303 Windsor Street, Halifax, N. S.
BEAM INSTRUMENTS CORPORATION
Room 907, 511 5th Avenue, New York 17, N.Y.

NEW WIDE BAND D.C. AMPLIFIER

MODEL 120

A precision instrument designed for use as a preamplifier in conjunction with an oscilloscope, vacuum tube voltmeter or other instruments.

SPECIFICATIONS

FREQUENCY RESPONSE: Within ± 1 db between D.C. and 100,000 cycles per second.

GAIN: Approximately 100.

INPUT CONNECTION: Double channel, can be used for single ended and push-pull signals or as a differential amplifier.

INPUT IMPEDANCE: One Megohm shunted by approximately 15mmf in each channel.

DUAL INPUT ATTENUATOR: One to one, 10 to one, 100 to one and "off" positions in each channel independently adjustable.

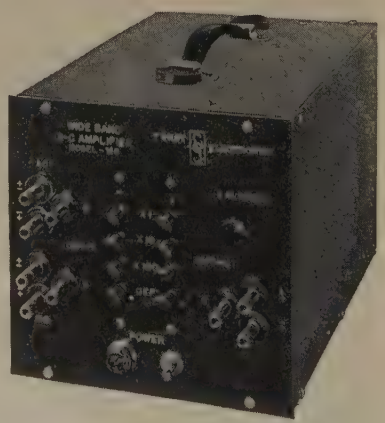
OUTPUT CONNECTION: Push-pull or single ended.

OUTPUT IMPEDANCE: Less than 50 Ohms single ended or 100 Ohms push-pull.

HUM AND NOISE LEVEL: Below 40 microvolts referred to input.

LOW DRIFT due to regulated heater voltage in input stage.

MOUNTING: Metal cabinet approximately 7" wide by 7" high by 11" deep.



Write for descriptive literature on the Model 120 D.C. Amplifier and other Furst laboratory instruments including Regulated Power Supplies.

FURST ELECTRONICS
14 S. Jefferson St., Chicago 6, Ill.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

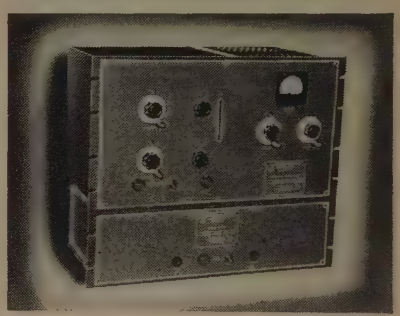
(Continued from page 87A)

This is a compact source of accurate frequency at a commonly needed power level. It is useful in running small motors, timers, and clocks. It is also useful in making frequency measurements, providing timing marks in oscillographs and high-speed cameras.

The source of the accuracy is a type 2001–2 240 cps tuning fork standard incorporated in the unit.

Frequency Shift Keyer

To meet more stringent requirements, **Northern Radio Co., Inc.,** 143 W. 22 St., New York 11, N. Y., has designed and produced the new Type 105 Model 4, frequency shift keyer.



(Continued on page 89A)

HIGHEST QUALITY ELECTRONIC COMPONENTS

Large Quantities in Stock for Immediate Delivery

RELAYS TUBES
TRANSFORMERS CHOKES
VOLUME CONTROLS RECTIFIERS
WIRE & CABLE TUBE SOCKETS
RESISTORS (WIRE WOUND, CARBON, etc.)
CONDENSERS (MOLDED, CERAMIC, OIL FILLED, etc.)
SWITCHES (TOGGLE, MINIATURE, WAFER, etc.)

All standard brands, inspected and guaranteed by Wells Sales.

Manufacturers: Write for complete Electronic Catalog and prices. Dept. P

WELLS SALES, INC.
320 N. LA SALLE ST.
CHICAGO 10, ILL.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 88A)

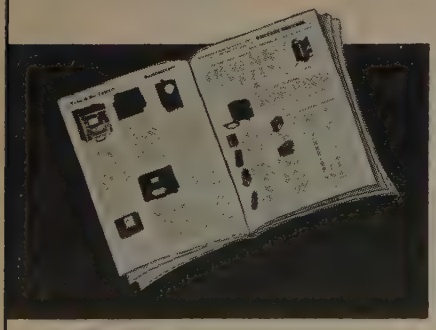
This exciter replaces the crystal oscillator in a transmitter and produces mark and space carrier shift for transmission of teleprinter or telegraph signals. It is composed of 6 main sections: keying circuit, reactance tube, shifted oscillator, crystal oscillator, modulator and power amplifier. Passing through the keying stage, a keying signal is limited in amplitude, then fed to the balanced reactance tube oscillator where it varies the frequency according to applied intelligence. This shifted frequency is heterodyned with the output from the crystal oscillator in the modulator stage, and the sum frequency drives the power amplifier.

Outstanding feature of the Type 105 Model 4 is the highly stable crystal oven which has a temperature control of $\pm 0.1°$ C at 60°, with heaters on 4 sides of the inner even.

Other features of this unit are direct reading frequency calibration of: shift from 0 to 1,000 cps; mixer and output tuning dials from 2.5 to 6.7 Mc; output frequency vernier ± 600 cps.

(Continued on page 91A)

If You Use Radio Parts



You Need SUN RADIO'S BIG NEW CATALOG

Sun Radio's New Electronic Parts catalog contains latest complete listings of component parts, instruments, tubes, wire, accessories. In an entirely new, easy-to-use, easy-to-file 8 1/2 x 11" format. For industry, research, universities, technical schools, technicians, engineers. Write for your FREE copy. Dept. C-I

Sun Radio & ELECTRONICS CO. INC.
122-124 DUANE ST. - NEW YORK 7, N.Y.

2 blocks North of Chambers St. - Est. 1922.
Hours: Daily 9-6, Saturday 9-4:30.

IT'S KINGS FOR CONNECTORS

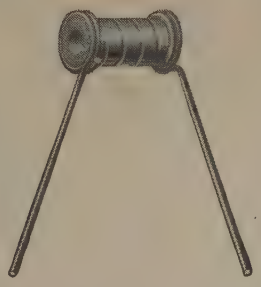
Pictured here are some of the more widely used R. F. co-axial, U. H. F. and Pulse connectors. They are all Precision-made and Pressurized when required. Over 300 types available, most of them in stock.

Backed by the name KINGS—the leader in the manufacture of co-axial connectors.
Write for illustrated catalogs. Department "T"

KINGS Electronics
811 LEXINGTON AVE., BROOKLYN 21, N. Y.

Manufacturers of Radar, Whip, and Aircraft antennas Microphone Plugs and Jacks.
Radar Assemblies, Cable Assemblies, Microwave and Special Electronic Equipment

For Stability . . . **CONTINENTAL "NOBLELOY" RESISTORS**



- Engineered Performance
- Metal Film
- Range 1/2 ohm to 30 megohm
- Ratings, 1/2, 1, 2 and 5 Watt
- Tolerance 1/2%, 1% and 5%

The "Nobleloy" type X resistors assure dependable operating characteristics for many critical applications at economical savings.

Write for further details

CONTINENTAL CARBON, INC. CLEVELAND 11, OHIO

MICROWAVE

PULSE TRANSFORMERS

G.E.K.-2745 .....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS $39.50
W.E. $166173 Hi-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc. to 2 mc. 2 sections parallel connected, potted in oil $36.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1.2 is 1.1:1, and between terminals 6-7 and 1.2 is 2:1 Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. $K2731 Repetition Rate: 635 PPS. Pri. Imp: Ohms. Sec. Imp: 450 Ohms Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW Rifar 2.75 Amp. $64.50

W.E. $D169271 Hi Volt input pulse Transformer $27.50
G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV Peak power out 100 KW G.E. ..$34.50
G.E. $K2748A. Pulse Input line to magnetron $36.00
$9262 Utah Pulse or Blocking Oscilator XFMR Freq. limits 790-810 cy-3 winding turns ratio 1:1:1 Dimensions 1 13/16 x 1¼" 19/32 .....$1.50
Pulse 131-AWP L-421435 ...$6.00
Pulse 134-BW-2F L-440895..$2.25
RAY-WX-4298F $93.50
GE-K6824730 .....$50.00
GE-K9216945 .....$50.00
#7766489—9332 .....
A 7766490— .....
UX 7350 .....$6.95
#9350(218961) $2.00
#352-7181 .....
AVAILABLE IN STOCK 9318 9280 WRITE

ARMY-NAVY TEST SETS

LU-1 Freq. Meter and Test Oscillator. Type CRV-TVN-9HU Power Supply. M.I.T. Rad. Lab.
TVN-8SE Klystron Power Supply. M.I.T. Rad. Lab.
CS60ABW Watt Meter—Wavemeter. 3 centimeter.
APR5 Receiver—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope, 115V AC input.
Dehydrator Unit CPD 10137 Automatic cycling.
Compressor to 50 lbs. Compl. for Radar XSMN. Line New $425.00
SO-3 Receiver, 30 mc. IF. 5 stages 6AC7, 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc. in ch. 13 vol. 23 M.I.T. Rad. Lab. Series $99.50

TS12 3 cm Slotted Line
TS13 3 cm Signal Generator
TS33 3 cm Frequency Meter
TS35 3 cm Signal Generator
TS36 3 cm Power Meter
TS45/AMP3 3 cm Signal Generator
TS62 3 cm Echo Box
TS102
TS108 Dummy Load
I—185A oscillator
I—158 Range Calibrator
I—233 Range Calibrator
BC—438 Freq Meter
RF—Preamp
GR—Capacity bridge $216
GR—Uni Galvo Shunt $229
GR—1000 Avd Osc $213
TS 226A/AP Power Meter O-1000W
Sig Gen $804 8-330 MC
BC 221 Freq Meter
TS 10/AP
TS 69/AP Freq Meter
I-114 Test Set

VARISTORS

D-170225 .....$1.50
D-167176 .....$1.50
D-168687 .....$1.50
D-171812 .....$1.50
D-171528 .....$1.50
D-168442 .....$3.00
D-165393 .....$1.25
D-98836 .....$2.00
D-161871A $2.85
D-171121 .....$1.50
D-162358(306A) .$1.50
D-163357 .....$2.00
D-99946 .....$2.95

THERMISTORS

D-167332 (tube) $1.50
D-170396 (bead) $1.50
D-167613 (button) $1.50
D-164699 for MTG in "X" band Guide $2.50
D-167018 (tube) $1.50

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$12.50
5200	11/32 in.	1 5/16 in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons $24.50 ea.
GE Magnets type M7765115, GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1⅝". New Part of SCR 584 .....$34.50

MAGNETRONS

QK 61	2J32	2J61	720CY	
QK 60	2J37	2J62	725-A	
2J21	2J38	3J31	730-A	
2J22	2J39	5J30	728	
QK 915	2J26	2J40	714AY	706
QK 62	2J27	2J49	718DY	700
QK 59	2J31	2J34	720BY	

Klystrons 723A, 707B, 417A, 2K41

RADIO SYSTEMS

White Radio Telephone Model $WRM55—ship to ship—shore to ship—small airports—mines—plantations — inter island — ranches. 10 channel fix tuned rec. & Xmitter. Xmitter, pwr. output in excess of 100W unmodulated into antenna of 18 & 100 MMF. Freq. Range 2-12 MC. Can be modified to increase range. Xtal controlled. 110V 60 cy or 220V 60 or 25 cy. Meas. 24" H x 19" W x 14" D. 125 lbs. Write or phone for data.
TAJ 500 Watt Low Frequency Transmitter 150-550KC CW-MCW.
TBK 500 Watt High Frequency Transmitter 2-18 MC. A1, A2, A3, Emission Mfg. by RCA.

THE MUST OF THE MONTH

Complete 3 CM Radar System Equipment

40 KW peak transmitter, pulse modulator, receiver, using 723AB, power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, all tubes, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

High Voltage Power Supply

15 KV at 30 Ma DC, Bridge Rectifier $125.00

MICROWAVE ANTENNAS

RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4' x 3' rectangle, now $35.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam. 115 v.a.c. drive. New $100.00
SC-13 ANTENNA 24" dish with feed-back dipole 360 deg. rotation, complete with drive motor and selsyn. New $128.00
Used $45.00
DBM ANTENNA. Dual, back-to-back parabolas with dipols. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00
AS125/APR. Cone type receiving antenna, 1080 to 3208 megacycles. New $4.50
140-600 MC CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50
ASD 3 cm. antenna, used, ex. cond. $49.50
YAGI ANTENNA AS-46A, APG-4, 5 elements .....$14.50 ea.
DISH FOR PARABOLA 30" $4.85
AN 122 .....$22.50
RC 224 .....$99.50
AS 17/APS
DAK Directional Finder Loops
Adcock Arrays
SA-1 Radar
200 MC. Bed Spring
LP21-A Airborne Dir. Find. Loop w/ Selsyn & Loop Housing
APS 4 Ant.
AN 128A 200 MC. Array
Write for Info and Price

RADAR SYSTEMS AND COMPONENTS IN STOCK

APS-2
10 CM AIRBORNE
APS-3
3 CM AIRBORNE
APS-4
3 CM AIRBORNE
APS-6
3 CM AIRBORNE
APS-6A
3 CM AIRBORNE
APS-10
3 CM AIRBORNE
APQ-13
3 CM AIRBORNE
APS-15
3 CM AIRBORNE
APS-31
3 CM AIRBORNE
CPN-8
10 CM GROUND BEACON
CEXH
10 CM GROUND BEACON
FD-MARK 4
800 MC SHIP GUNLAYING
MARK-10
10 CM SHIP GUNLAYING
SA
200 MC SHIP AIR SEARCH
SC
200 MC SHIP AIR SEARCH
SD
200 MC SUBMARINE
SE
10 CM SURFACE SEARCH
SF
10 CM SURFACE SEARCH
SG
10 CM SURFACE SEARCH
SJ
10 CM SUBMARINE
SK
200 MC AIR SEARCH
SL
10 CM SURFACE SEARCH
SN
10 CM PORTABLE
SO (ALL SERIES)
10 CM SURFACE SEARCH
SQ
10 CM PORTABLE
SW
200 MC PORTABLE
SCR 518
400 MC ALTIMETER
SCR 520
10 CM AIRBORNE
SCR 533
200 MC AIR SEARCH
SCR 545
10 CM TRACKING 800 MC SEARCH
SCR 663
SEARCHLIGHT TRACK

SONAR SYSTEMS AND COMPONENTS IN STOCK

QBF
QBG
QC
QCJ
QCL
QCO
QCS
QCU
WEA

3000 MC BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type. Type N Fittings. Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT-39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Used 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice .....$47.50 ea.
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters. Type "N", input and output $12.50
726 Klystron Mnt. Tunable output, to type "N" complete, with socket & Mtg. bracket ...$12.50

WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER. CHOKE FLANGE. SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER. 27 db. Navy type CABV-47AAN. with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter. 18 in. long QA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees ..$75.00 per set
POWER SPLITTER: 726 Klystron input dual "N" output ..$5.00

⅞" RIGID COAX

10 CM FEEDBACK DIPOLE ANTENNA. in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated .....$2.00 ea.
Magnetron Coupling with TR Loop, ...$7.50
Sperry Rotating Bend, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length ..$7.50
Short Right Angle Bends (for above) $2.50

4000 to 6000 mcs. Bench Test Plumbing 2" x 1" WAVEGUIDE

SLOTTED LINE. DeMornay type 332 complete with probe, etc. $600.00
FLAP ATTENUATOR $48.00
VARIABLE STUB TUNER AND LOW POWER TERMINATION $48.00
WAVEMETER TEE $48.00
ADAPTERS:
Choke to choke $18.00
Cover to cover $14.00
Choke to cover $16.00
WAVEGUIDE TO TYPE "N" ADAPTER $45.00
DIRECTIONAL COUPLER. Two hole type, type "N" output $48.00
KLYSTRON MOUNT. Equipped with tunable termination and micrometer adjust. klystron antenna tuning $110.00
CRYSTAL MOUNT. Equipped with tunable termination and micrometer adjust crystal tuning $125.00
TUNABLE TERMINATION. Precision adjust $90.00

6000 Mc. to 8500 Mc. Bench Test Plumbing 1½" x ¾" WAVEGUIDE

KLYSTRON MOUNT. DB356 complete with shield and tunable termination $125.00
FLAP ATTENUATOR. DB361 .....$45.00
VARIABLE STUB TUNER $90.00
WAVEGUIDE TO TYPE "N" ADAPTER $18.50
WAVEMETER TEE. DB352 .....$32.50
MAGIC TEE $80.00
DIRECTIONAL COUPLER. Two hole 25DB coupling, type "N" output $25.00
PRECISION CRYSTAL MOUNT. Equipped with tuning slugs and tunable termination $125.00
TUNABLE TERMINATION. Precision adjust $70.00
LOW POWER LOAD $35.00

8500 Mc. to 9600 Mc. Bench Test Plumbing 1" x 1½" WAVEGUIDE

KLYSTRON MOUNT. DeMornay Budd type DB380 for 2K25, etc., includes tunable termination $70.00
VARIABLE STUB TUNER. DB536, 180 degree phase shifting capacity $70.00
FLAP ATTENUATOR. DB385. Maximum Attenuation 10DB $25.00
Waveguide to "N" Adapter DB377 .....$15.00
LOW POWER TERMINATION. DB381 .....$18.50
UNI-DIRECTIONAL COUPLER. DB390. 23DB type "N" output $18.50
PICK UP HORN. Type "N" output $4.50
WAVEMETER. 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type $85.00
WAVEGUIDE LENGTHS. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections .....$2.00 per ft.
90 DEGREE ELBOWS. E or H plane, 2½" radius ...$12.50
MITERED ELBOWS. E plane $10.00
90 DEGREE TWIST. 6" long $8.00
BULKHEAD FEED—THRU ASSEMBLY $15.00
PRESSURE GAUGE SECTION. 15 lb. gauge and press. nipple $10.00
PRESSURE GAUGE. 15 lbs. $2.50
DUAL OSCILLATOR-BEACON MOUNT. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields $42.50
DUAL OSCILLATOR MOUNTS. (Back to back) with crystal mount, tunable termination, attentuating slugs $18.50
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Rotary Joint Choke to Choke $10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50

1¼" x ⅝" WAVEGUIDE

TUNABLE TERMINATION. Precision adjust $65.00
LOW POWER TERMINATION $25.00
MAGIC TEE $45.00
OSCILLATOR MOUNT. for four 723AB klystron $38.50
90 DEGREE ELBOWS. E or H plane $12.50
WAVEGUIDE LENGTHS. Cut to size and supplied with 1 choke. 1 cover. per length $2.00 per ft.
WAVEMETER: Absorption type. Precision micrometer adjust. Very high Q $150.00

23,000 TO 27,000 MC. BENCH TEST PLUMBING ½" x ¼" WAVEGUIDE

PRECISION SLOTTED LINE. Adjustable probe $200.00
DIRECTIONAL COUPLER-Wavemeter Mount. 12DB $60.00
PRECISION VARIABLE ATTENUATOR, mfg. Bernard Rice $90.00
LOW POWER LOAD $20.00
SHUNT TEE $35.00
WAVEGUIDE LENGTHS. 2" to 6" long, goldplated with circular flanges and coupling nuts .....$2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS32 .....$49.50
Mit. Elbow, cov. to cov. $4.00
TR-ATR Sect. choke to cov. $4.00
Flex. Sec. 1" choke to choke $5.00
"S" Curve Choke to Cover .$4.50
Adaptor, rnd. to sq. cov. ...$5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" $1.00 per ft.
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB $49.50 ea.
3J31 Magnetrons $55.00

All merch. guar. Mail orders promptly filled. All prices, F.O.B., N.Y.C. Send Money Order or Check. Only shipping charges sent C.O.D. Rated Concerns send P.O.

COMMUNICATIONS EQUIPMENT COMPANY

131 LIBERTY STREET NEW YORK, N.Y. DEPT. 112 P. J. PLISHNER MAin 4-8373

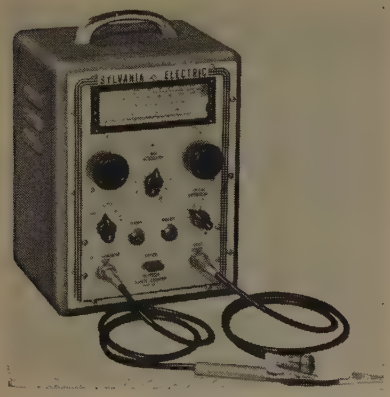
News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 89A)

Television Marker Generator

A new television marker generator, Type 501, designed particularly for use with TV sweep signal generators, has been announced by the **Radio Tube Div., Sylvania Electric Products Inc.,** 1740 Broadway, New York 19, N. Y.

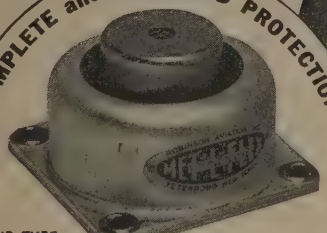


Crystal-controlled signals are provided by an entirely separate self-contained crystal oscillator which may be operated at any frequency, fixed by a plug-in crystal with-

(Continued on page 93A)

All-Metal... All-Weather MOUNTS

COMPLETE and BALANCED PROTECTION



(CUP TYPE MODEL #7002)

MET-L-FLEX

Unit mounts and mounting systems with MET-L-FLEX provide vibration isolation and true shock absorption through the widest range of operating conditions. All-metal • no organic materials • stable characteristics from −90° C. to +175° C. • wide load tolerance • built-in damping for stability and reduced amplification at resonance.

For electronic or delicate equipment mounting, write Dept. 825 MET-L-FLEX Data Sheets available.

ROBINSON AVIATION INC.
TETERBORO, NEW JERSEY
Vibration Control Engineers

WHAT SCARCITY?

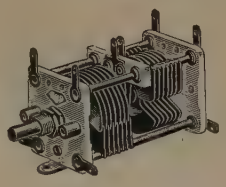
There never is a scarcity of QUALITY and VALUE

in BUD VARIABLE CONDENSERS

Today is the time to look for savings! Note the prices on our condensers and compare. You will find that the entire Bud line maintains greater value while giving you the best quality and service. Illustrated below are two types of Bud condensers—there are over 400 different variable condensers in the Bud line. Consult your dealer for your requirements.

BUD "CE" TYPE DUAL MIDGET CONDENSERS

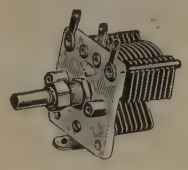
1. Extremely efficient, they embody everything that any other condenser has PLUS a positive rotor wiping contact in the exact electrical and physical contact permitting the design of balanced circuits.
2. Ball bearings are featured on this double bearing condenser for centering and elimination of end-play.
3. Any of three methods of mounting can be used.
4. Alignment is maintained by 4 rigid tie rods.
5. Two solder lugs on each stator permit the placement of other components for efficient, short lead design.



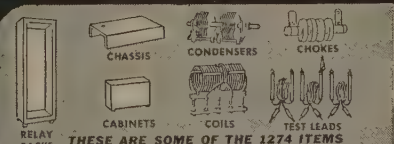
Catalog Number	Max. Cap.	Min. Cap.	No. of Plates	Air Gap	Distance Behind Panel	Dealer Cost
			PER SECTION			
CE-2032	35	6	7	.030"	3 1/32"	$2.97
CE-2033	50	7	9	.030"	3 ¼"	3.27
CE-2034	75	8	14	.030"	3 21/32"	3.63
CE-2035	100	9	18	.030"	4 3/32"	4.14
CE-2036	150	10	27	.030"	5 3/16"	4.80
CE-2039	15	5	5	.060"	3 1/32"	3.45
CE-2040	35	7	11	.060"	4 1/32"	3.96
CE-2041	50	8	15	.060"	4 23/32"	4.35

BUD "CE" MIDGET CONDENSERS-SINGLE BEARING

1. Any of the three methods of mounting can be utilized.
2. Extended rotor shaft allows ganging of two or more condensers.
3. Smooth operating and noiseless bearings permit operation on high frequencies and prevent capacity changes.



Catalog Number	Max. Cap. MMFD.	Min. Cap. MMFD.	Air Gap	No. of Plates	Over-all Length	Dealer Cost
CE-2020	15	4	.030"	3	1 11/16"	$1.65
CE-2021	35	6	.030"	7	1 29/32"	1.86
CE-2022	50	7	.030"	9	2 1/32"	2.07
CE-2023	75	8	.030"	14	2 ¾"	2.31
CE-2024	100	9	.030"	18	2 15/32"	2.49
CE-2025	150	10	.030"	27	3"	2.64
CE-2028	15	5	.060"	5	1 15/16"	1.86
CE-2029	35	7	.060"	11	2 7/16"	2.07
CE-2030	50	8	.060"	15	2 25/32"	2.31



THESE ARE SOME OF THE 1274 ITEMS AVAILABLE FROM BUD RADIO, INC.

BUD RADIO, INC.

BUD

2110 E. 55th ST. • CLEVELAND 3, OHIO

G-H, "CUSTOM-MANUFACTURED"

CAPACITORS

Girard-Hopkins PERMANOL impregnated, paper-dielectric capacitors have consistently supplied the answer to the capacitor problem of many manufacturers of precision electronic equipment. If you require permanent, non-ageing characteristics, maximum stability, low power-factor change with frequency and utmost protection against voltage breakdown, G-H PERMANOL will meet your requirements. Custom-manufactured for you in any reasonable capacity, tolerance and working voltage any type of container . . . small or production quantities.

One of the best equipped capacitor manufacturing plants on the Pacific Coast

GIRARD-HOPKINS

1000 40th Avenue, Oakland 1, Calif.

KENYON *Fits Your Production To A "T"*

KENYON "T's"—high quality, uniform transformers, are your best bet for development, production and experimental work. For over 20 years, the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

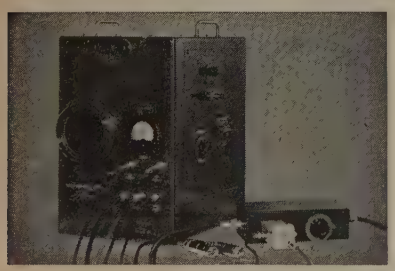
Now—reduce inventory problems, improve deliveries, maintain your quality—specify KENYON "T's," the finest transformer line for all high quality equipment applications.

New Catalog Edition! Write Today!

KENYON new modified edition tells the complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for your copy of our latest catalog edition *now!*

KENYON TRANSFORMER CO., Inc.
840 BARRY STREET · NEW YORK 59, N. Y.

Test Equipment FOR RADAR and PULSE APPLICATIONS

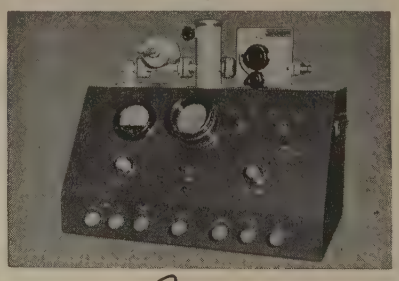


MODEL 705 WOBBULATOR

Swept signal output with center frequency adjustable from 2 to 500 mc.
Continuous swept output adjustable from 0 to 100 mc./sec. with 0.1 volt output at 50 ohms.
Internally synchronized scope with detectors and amplifiers.
High and low impedance shielded traveling detectors.
Output designed for making response measurements at 3000 mc., IF frequencies, and Video.

MODEL 708 SPECTRUM ANALYZER

Frequency range—8500 mc to 9600 mc.
Receiver—Double conversion superheterodyne.
IF bandwidth—approximately 10 kc.
Sweep frequency—10 cps to 25 cps.
Minimum frequency dispersion—1 mc/inch.
Maximum frequency dispersion—10 mc/inch.
Signal input attenuator—100 db linear.
Power—115V or 230V, 50 cps to 800 cps.



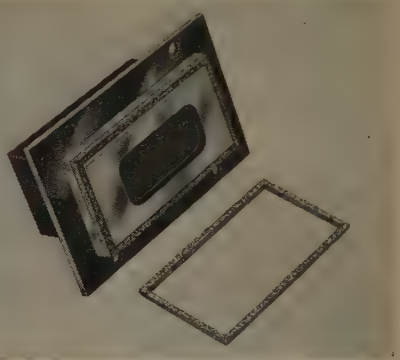
Write for complete technical data

Canoga *corporation*
14315 Bessemer St., Van Nuys, Calif. · Box 361

"We have found Metex Electronic Gaskets excellent for HF currents inexpensive to assemble."
Sylvania Electric Products Inc.

Sylvania has been using Metex gaskets for over a year as conductive shields for their TR tubes used in radar and micro-wave ranging equipment.

To quote their experience: "We have found Metal Textile knitted wire gaskets excellent for conducting high frequency currents without boundary arcing. The gaskets are resilient, and yet do not deform too readily. Best of all, the material is inexpensive to assemble through soft soldering techniques."



A Sylvania Electric TR tube showing Metex gasket loose and in position

The properties—electrical and physical—which make Metex Electronic Gaskets effective in this, and other demanding HF and UHF applications are due to their being made from *knitted* (not woven) wire mesh. The hinge-like action of the knitted mesh permits controlled resiliency of the finished gaskets. These can be die-formed to close dimensional tolerances, when required. There is practically no limit to the metal or alloy which can be used.

If the equipment you are manufacturing or designing requires a resilient conductive or shielding material, our engineers will welcome the opportunity of working with you. A letter, addressed to Mr. R. L. Hartwell, Executive Vice President and outlining your requirements, will receive immediate attention.

METAL TEXTILE CORPORATION
637 EAST FIRST AVE., ROSELLE, N. J.

News—New Products

These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 91A)

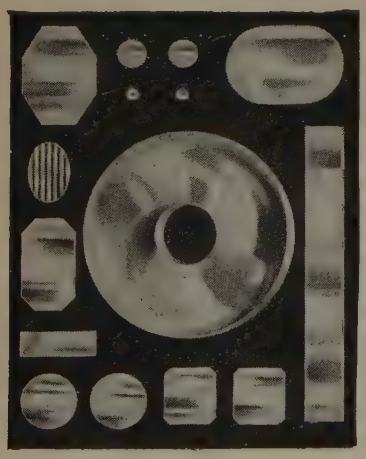
out tuning. It provides check points at fundamental frequencies ranging from 2 to 20 Mc, and has useful harmonics up to at least the sixth.

Two marker pips may be used to set video and *if* circuits and traps, as required by some TV manufacturers, or the variable marker may be brought into coincidence with the crystal marker to check dial reading with crystal frequency or crystal frequency harmonic.

The oscillator provides frequencies ranging from 15 to 240 Mc in four bands: 15 to 30 Mc; 30 to 60 Mc; 60 to 120 Mc; and 120 to 240 Mc. With an appropriate crystal inserted in the panel socket, the oscillator will operate at any frequency between 2 to 20 Mc, and will provide useful harmonic output up to the sixth for all band calibration.

Front-Surface Mirrors

Zenith Optical Laboratory, 123 W. 64 St., New York 23, N. Y., announces the development of their Zeno-Kote process, for producing front-surface mirrors which are durable and tarnish-resistant. The reflecting surface is produced by thermal evaporation of a special aluminum alloy under high vacuum. The reflecting surface is then protected by the deposition of an extremely hard but transparent film, which in no way affects the reflectivity of the mirrors.



Mirrors produced by the Zeno-Kote process have a reflectivity of about 93 per cent in the visible spectrum, and they can be made to meet any optical or dimensional tolerance.

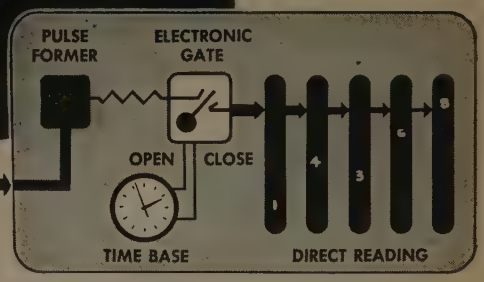
The usual aluminized front-surface mirrors are very delicate and can be cleaned only with great difficulty, whereas front-surface mirrors produced by the Zeno-Kote process can be dusted or wiped without damage to the reflecting surface.

These mirrors are suitable for use in precision electronic and optical equipment, where high and permanent reflectivity characteristics are necessary.

(Continued on page 94A)

Introducing the Berkeley

EPUT* METER



NOW . . . determine Events-Per-Unit-Time* *automatically* with a single, compact direct-reading instrument!

Any physical, electrical or optical events of unknown occurrence rate that can be translated into changing voltages can be accurately counted during a precisely-measured time interval of one second. (Time base other than one second can be provided.)

In frequency measurements, for example, each cycle occurring during the accurately timed one-second interval is individually counted and the total displayed in direct-reading numerals on the illuminated front panel. Maximum counting rate is 100,000 per second; accuracy is ±1 event regardless of rate.

Send for bulletin PI-554 for full, detailed description.

Berkeley Scientific Corporation

2200 WRIGHT AVE. • RICHMOND, CALIF.

SMALL

PARTS

Cost less when made by

MULTI-SWAGE

The economy way to get a million small parts similar to these —

Examine the tubular metal parts shown here twice size. If you use anything similar . . . in large quantities . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,

Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

PROFESSIONAL CARDS

LESTER W. BAILEY
Registered Patent Agent
Senior Member IRE
PATENT OFFICE PRACTICE specializing in
ELECTRONICS MECHANICS
RADIO
LINCOLN-LIBERTY BUILDING
PHILADELPHIA 7
Broad & Chestnut Streets Rittenhouse 6-3267

ALFRED W. BARBER LABORATORIES
Specializing in the Communications Field and in Laboratory Equipment
Offices, Laboratory and Model Shop at:
32-44 Francis Lewis Blvd., Flushing, L.I., N.Y.
Telephone: Independence 3-3306

HAROLD J. BROWN
Vibrators
Vibrator Power Supplies
Electrical Contact Systems
Mattapoisett, Mass.

W. J. BROWN
International Electronics Consultant
AT PRESENT IN GREAT BRITAIN
Will undertake assignments for American or British Clients. Please address inquiries to 11 Public Square, Cleveland 13, Ohio.
TO 1-6498 FA-1-0030

EDWARD J. CONTENT
Acoustical Consultant
Functional Studio-Theater Design
FM — Television — AM
Audio Systems Engineering
Roxbury Road Stamford 3-7459
Stamford, Conn.

CROSBY LABORATORIES, INC.
Murray G. Crosby & Staff
Radio-Electronic Engineering,
Research & Development
FM, Communications, TV
Test Equipment
Offices, Laboratory & Model Shop at:
126 Herricks Rd., Mineola, N.Y.
Garden City 7-0284

Richard B. Schulz
Electro-Search
Radio-Interference Reduction;
Development of
Interference-Free Equipment,
Filters, Shielded Rooms
515 W. Wyoming Ave., Philadelphia 40, Pa.
GLadstone 5-5353

ELK ELECTRONIC LABORATORIES
Jack Rosenbaum
Specializing in the design and development of
Test Equipment for the communications, radar and allied fields.
333 West 52nd St. Telephone:
New York 19, N.Y. PLAZA 7-0520

WILLIAM L. FOSS, INC.
927 15th St., N.W. REpublic 3883
WASHINGTON, D.C.

PAUL GODLEY CO.
Consulting Radio Engineers
P.O. Box J. Upper Montclair, N.J.
Offs & Lab.: Great Notch, N.J.
Phone: Montclair 3-3000
Established 1926

HERMAN LEWIS GORDON
Registered Patent Attorney
Patent Investigations and Opinions
Warner Building 100 Normandy Drive
Washington 4, D.C. Silver Spring, Md
National 2497 Shepherd 2433

HOGAN LABORATORIES, INC.
John V. L. Hogan, Pres.
APPLIED RESEARCH, DEVELOPMENT, ENGINEERING
Est. 1929. Exceptionally competent staff. Electronics, Optics, Mechanisms, Facsimile Communication, Electro-sensitive recording media, Instrumentation.
155 Perry Street, New York 14 CHelsea 2-7855

MEASUREMENTS CORP.
RESEARCH & MANUFACTURING ENGINEERS
Harry W. Houck Jerry B. Minter
John M. van Beuren
Specialists in the Design and Development of Electronic Test Instruments
BOONTON, N.J.

Eugene Mittelmann, E.E., Ph.D.
Consulting Engineer & Physicist
High Frequency Heating—Industrial Electronics
Applied Physics and Mathematics
549 W. Washington Blvd. Chicago 6, Ill.
State 2-8021

PICKARD AND BURNS, INC.
Consulting
Electronic Engineers
240 HIGHLAND AVE.
NEEDHAM, MASS.

SERVO CORPORATION OF AMERICA
Henry Blackstone, President
Consultants on
Electronic Control Problems
for Industry
New Hyde Park Long Island, N.Y.

TELREX, INC.
M. D. Ercolino, Pres.
H. F. ANTENNA SPECIALISTS
● The Skill to Design
● The Facilities to Produce
● The Ability to Deliver
Asbury Park, N.J.—Phone AP 2-7252

TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS CONSULTANTS
RADIOTELETYPE - FREQUENCY SHIFT
INK SLIP RECORDING - TELETYPE NETWORKS
121 Spencer Place, Mamaroneck, N.Y.

News—New Products

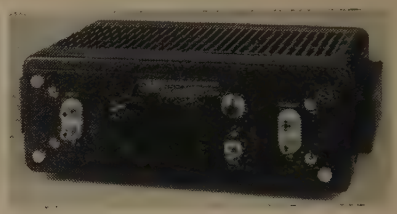
These manufacturers have invited PROCEEDINGS readers to write for literature and further technical information. Please mention your I.R.E. affiliation.

(Continued from page 93A)

CORRECTION NOTICE

Wide-Band Decade Amplifier

Type 500-A wide-band decade amplifier has been developed by **Technology Instrument Corp.,** 1058 Main St., Waltham, Mass., for general laboratory use and for special applications requiring zero phase shift on high stability of gain. To increase the general utility of the amplifier, compact construction, cabinet or rack mounting, and ac operation from a self-contained power supply have been incorporated in the design.



Input impedance is high enough to permit measurements in most circuits without upsetting normal conditions.

Output impedance is low enough to permit operation into a wide range of loads without causing a variation from the indicated gain of *10, 100 or 1,000 times.*

Maximum output of 20 v on any gain setting insures sufficient amplitude for the operation of most devices used in conjunction with general purpose laboratory amplifiers.

Zero phase shift from 20 cps to 100 kc (all instruments adjusted as close as practical to zero—some might exhibit an error of 2° unless requested otherwise) makes possible the extension of phase measurements *to 5-mv levels,* when used with TIC Type *320 phase meter.*

Gain stabilized by feedback, so that it is constant with line voltage or tube changes.

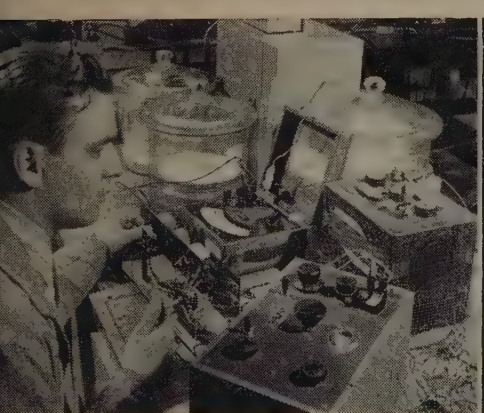
PROFESSIONAL CARDS

WHEELER LABORATORIES, INC.
Radio and Electronics
Consulting — Research — Development
R-F Circuits — Lines — Antennas
Microwave Components — Test Equipment
Harold A. Wheeler and Engineering Staff
Great Neck, N.Y. Great Neck 2-7806

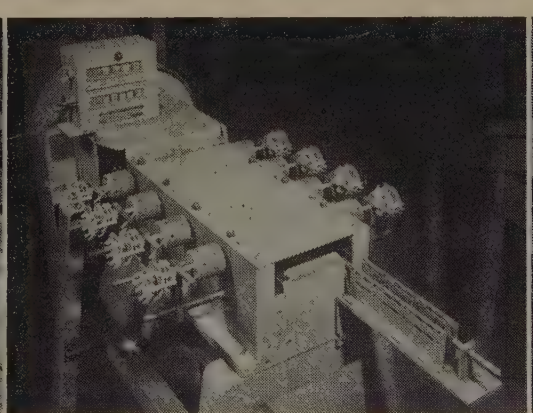
ADVENTURES IN ELECTRONIC DESIGN

TORTURE TESTS PROVE SWITCH PERFORMANCE

Turn it on. Turn it off. Do this 25,000 times or more and you'll get a good idea of the terrific punishment Centralab switches must be able to withstand. Day and night, skilled CRL engineers and specially designed testing machines put Centralab switches through torture tests no switch is ever asked to undergo in ordinary operation. What does this mean to you? Just this. You can be sure that Centralab gives you the smooth operation, positive indexing and accurate positioning you want in the switches you buy. What's more, you can be sure CRL switches will continue to provide these advantages for a long, long time.



Constant checking makes sure CRL switches give you desirable uniform low contact resistance. Here an engineer tests resistance by running 1 ampere through contacts.

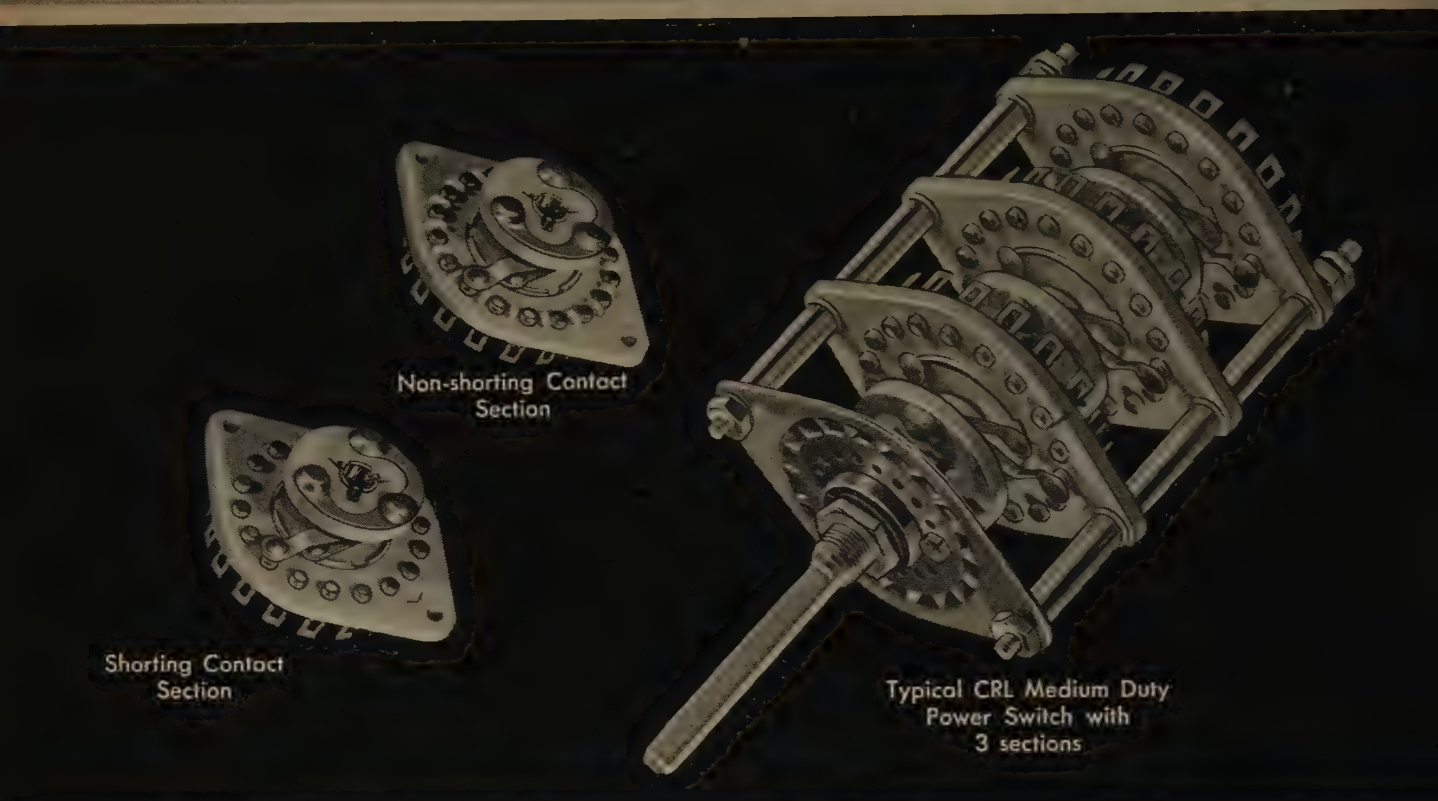


Accelerated life test machine rotates through fixed number of positions at 1000 cycles per hour . . . proves switch springs, clips and contacts stand up under long, hard use.

Resistance of switch insulation to atmosphe change is tested in controlled temperat and humidity chamber. Test helps av breakdown or leakage.

Centralab — **DEVELOPMENTS THAT CAN HELP YOU**

Centralab Components

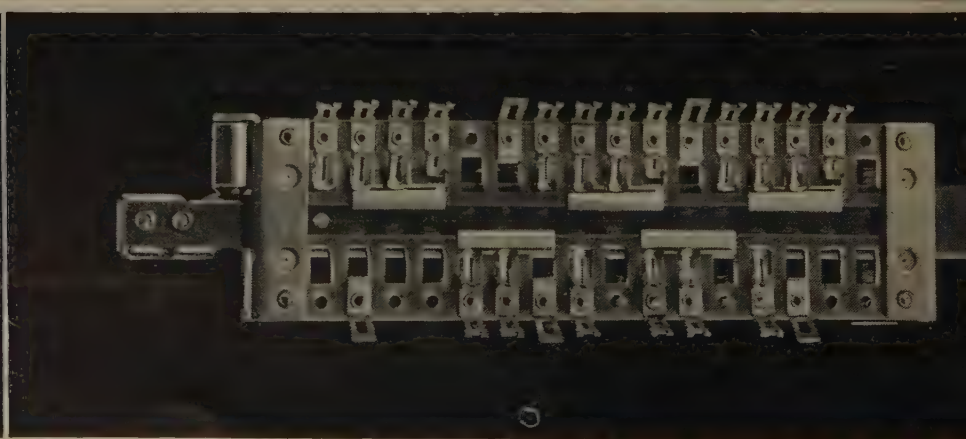


1 Yes, CRL's Medium Duty Power Switches are made to meet your individual needs . . . single, two or three poles . . . 18 contacts per section . . . up to 20 sections per shaft. Contacts and collector rings of coin silver, mounted on Grade L5 Steatite, compounded and produced right in our own plant . . . backed up by 20 years of ceramic manufacturing experience.

These switches are designed for R. F. or 7½ amp. 110-115 V. application. Voltage breakdown to ground, 3000 V. RMS 60 cycles.

The combination of rugged construction — coin silver contacting members, plus the high insulation resistance of Grade L5 Steatite, means trouble-free performance in x-ray, lab-test equipment, high voltage transmitters and other electronic gear.

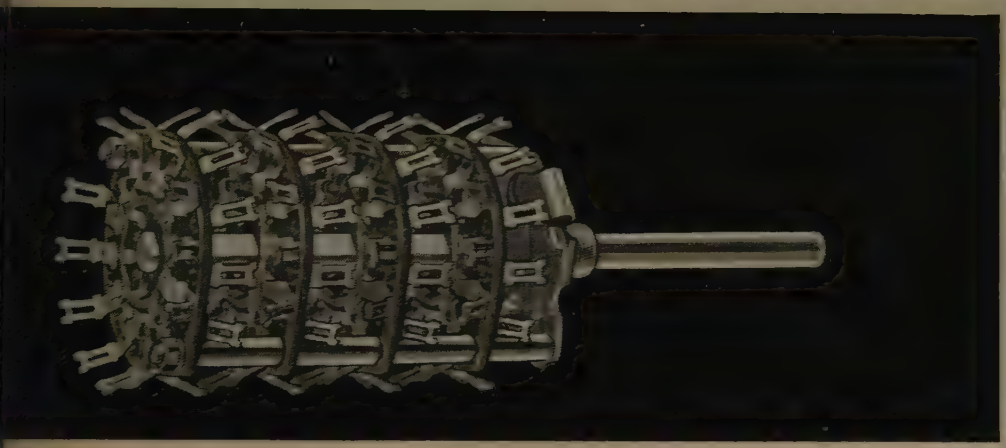
For top-performing medium duty power switches, built for life-time service — in standard or custom built models — ask about CRL's "torture tested" power switch line. Our engineers will be glad to assist you.



2 Great step forward in switching is CRL's New Rotary, Coil, Spring and Cam Index Switch. It gives you smoother action, longer life.

3 Centralab's development of a revolutionary, new *Slide Switch* vastly facilitates AM and FM set design! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. CRL Slide Switches are rugged and dependable.

for Electronic Gear



4 24 insulated clips per section assure variety of switching combinations. This double-wipe style switch can be CRL built to your specifications. Successfully used in TV up to 200 megacycles. Ratings: 1 amp at 6 v. Stator and rotor highest grade laminated phenolic. Clips silver-plated or silver alloy.

5 CRL's new high quality Model 2 Radiohm Controls specifically designed for TV, radio, other electronic equipment. Lower noise level, longer life.

6 For by-pass or coupling applications, check Centralab's original line of ceramic disc Hi-Kaps. Disc Hi-Kaps are smaller than a dime.

7 Hi-Vo-Kaps (10-20-30 kv) are filter and by-pass capacitors combining high voltage, small size and variety of terminal connections to fit most TV needs.

8 Ceramic Trimmers are made in five basic types. Full capacity change within 180° rotation. Spring pressure maintains constant rotor balance.

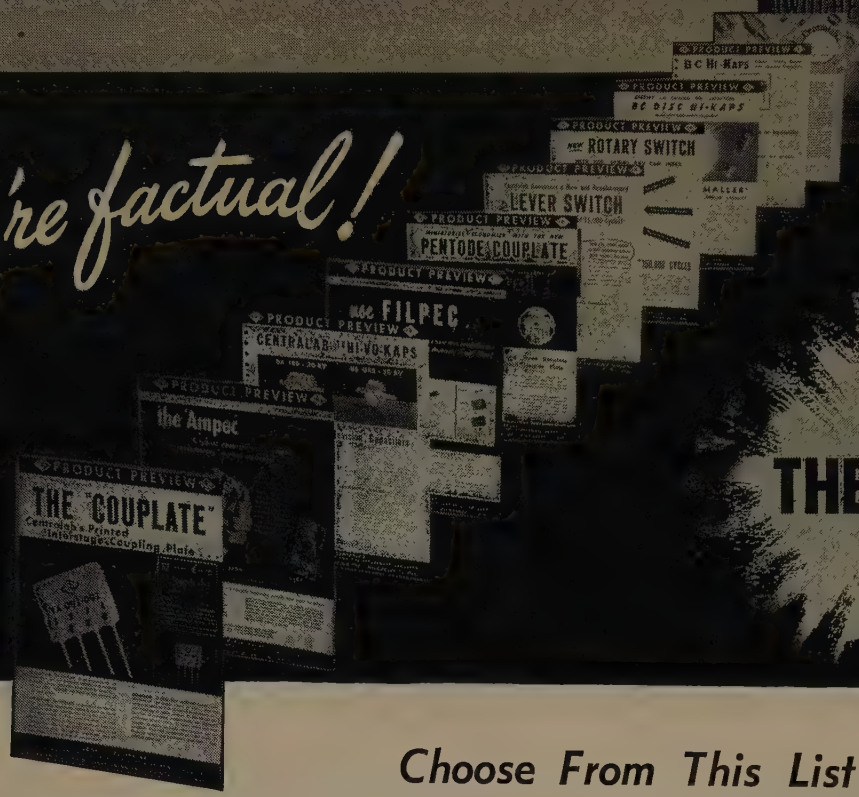
9 Centralab's *Ampec*, above, is an integral assembly of tube sockets, capacitors, resistors and wiring combined into one miniature amplifier unit.

10 Couplate consists of plate and grid resistors, plate by-pass and coupling capacitors. Minimum soldered connections speed production.

11 This is the new CRL Vertical Integrator Network used in TV sets. Variations of this Centralab integrator plate are available on special order.

IMPORTANT BULLETINS FOR YOUR TECHNICAL LIBRARY!

They're factual!



THEY'RE FREE!

Choose From This List!

Centralab Printed Electronic Circuits

973 — AMPEC — three-tube P. E. C. amplifier.
42-6 — COUPLATE — P. E. C. interstage coupling plate.
42-22 — VERTICAL INTEGRATOR — for TV application.
42-24 — CERAMIC PLATE COMPONENTS — for use in low-power miniature electronic equipment.
42-27 — MODEL 2 COUPLATE — for small or portable set applications.
999 — PENTODE COUPLATE — specialized P. E. C. coupling plate.
42-9 — FILPEC — Printed Electronic Circuit filter.

Centralab Capacitors

42-3 — BC TUBULAR HI-KAPS — capacitors for use where temperature compensation is unimportant.
42-4R — BC DISC HI-KAPS—miniature ceramic BC capacitors.
42-10R — HI-VO-KAPS — high voltage capacitors for TV application.
42-59 — CERAMIC TUBULAR TRIMMERS — designed for TV and VHF application.
42-101 — CERAMIC TRIMMERS — CRL trimmer catalog.
981 — HI-VO-KAPS — capacitors for TV application. For jobbers.
42-18 — TC CAPACITORS — temperature compensating capacitors.
42-102 — CAPACITORS — high-voltage capacitors.
975 — FT HI-KAPS — feed-thru capacitors.

Centralab Switches

953 — SLIDE SWITCH — applies to AM and FM switching circuits.
970 — LEVER SWITCH — shows indexing combinations.
995 — ROTARY SWITCH — schematic application diagrams.
722 — SWITCH CATALOG — facts on CRL'S complete line of switches.

Centralab Controls

42-19 — MODEL "1" RADIOHM — world's smallest commercially produced control.
42-85 — MODEL 2 RADIOHM — CRL's new line of 15/16" diam. controls for TV — AM — FM.

Centralab Ceramics

967 — CERAMIC CAPACITOR DIELECTRIC MATERIALS.
720 — CERAMIC CATALOG — CRL steatite, ceramic products.

Look to CENTRALAB in 1951! First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. For complete information on all CRL products, get in touch with your Centralab Representative. Or write direct.

CENTRALAB
Division of Globe-Union Inc.
920 East Keefe Avenue, Milwaukee, Wisconsin

Yes—I would like to have the CRL bulletins, checked below, for my technical library!

☐ 973 ☐ 42-24 ☐ 42-9 ☐ 42-10R ☐ 981 ☐ 953 ☐ 42-19
☐ 42-6 ☐ 42-27 ☐ 42-3 ☐ 42-59 ☐ 42-18 ☐ 995 ☐ 967
☐ 42-22 ☐ 999 ☐ 42-4R ☐ 42-101 ☐ 42-102 ☐ 970 ☐ 720
☐ 975 ☐ 722 ☐ 42-85

Name.....

Address.....

City.....State.....

TEAR OUT COUPON
for the Bulletins you want

Centralab
CRL
®
Division of GLOBE-UNION INC. • Milwaukee

INDEX AND DISPLAY ADVERTISERS

Section Meetings 38A
Student Branch Meetings 44A
Membership 49A
Positions Open 50A
Positions Wanted 54A
News-New Products 68A

DISPLAY ADVERTISERS

Acme Electric Corp. 86A
Aircraft Radio Corp. 24A
Airtron, Inc. 79A
Allen-Bradley Co. 15A
Allison Radar Corp. 74A
American Lava Corp. 17A
Amperex Electronic Corp. 86A
Andrew Co. 68A
Armour Research Foundation 52A
Arnold Engineering Co. 31A
Astatic Corp. 70A

Lester W. Bailey 94A
Ballantine Laboratories 44A
A. W. Barber 94A
Barker & Williamson 75A
Bead Chain Mfg. Co. 93A
Bell Aircraft Corp. 55A
Bell Telephone Labs. 2A
Bendix Aviation (Red Bank) 45A
Bendix Aviation (Research Labs.) 52A
Berkeley Scientific Corp. 93A
Bliley Electric Co. 49A
Boeing Airplane Co. 50A
Boonton Radio Corp. 86A
Breeze Corp. 48A
Harold J. Brown 94A
W. J. Brown 94A
Browning Labs. 74A
Bud Radio, Inc. 91A
Burlington Instrument Co. 87A

Cambridge Thermionic Corp. 73A
Cannon Electric Development Co. 78A
Canoga Corp. 92A
Capehart-Farnsworth Corp. 54A
Capitol Radio Eng. Inst. 58A
Centralab 33A, 34A, 35A, 36A
C. P. Clare & Co. 23A
Cleveland Container Co. 5A
Sigmund Cohn Corp. 71A
Communication Products Co. 62A
Communications Equipment Co. 90A
E. J. Content 94A
Continental Carbon Co. 89A
Cornell-Dubilier Electric Corp. ..... Cover III
Cossor, Ltd. 88A
Crosby Labs. 94A

H. L. Dalis 77A
Daven Co. 9A
DeJur Amsco Corp. 43A
Dow Corning Corp. 70A
Allen B. DuMont Labs. 22A
E. I. DuPont de Nemours & Co. 52A

Eitel-McCullough, Inc. 20A
Electrical Industries 85A
Electrical Reactance Corp. 3A
Electro-Motive Mfg. Co. 7A
Electro-Search 94A
Elk Electronics 94A
Emsco Derrick & Equipment Co. 75A
Erie Resistor Corp. 19A

Federal Telecommunication Labs. 28A
Ferranti Electric Inc. 49A
W. L. Foss 94A
Franklin Institute 52A
Furst Electronics 88A

General Electric Co. ..... 10A, & 11A, 25A, 37A
General Precision Laboratory, Inc. 21A
General Radio Co. ..... Cover IV
G. M. Giannini & Co. 76A
Girard-Hopkins 91A
Paul Godley 94A
H. L. Gordon 94A
Green Instrument Co. 87A
Guardian Electric Mfg. Co. 41A

Haydu Brothers 80A
Helipot Corp. 53A
Hewlett-Packard Co. ..... 26A & 27A
Hogan Labs. 94A
Hughes Aircraft Co. 55A, 58A
Hughey & Phillips 80A

International Resistance Co. ..... 12A & 13A

JFD Mfg. Co. 81A
Jacobs Inst. Co. 55A
Jet Propulsion Lab. 55A

Kenyon Transformer Co. 92A
Kings Electronics 89A
Kollsman Inst. 69A
James Knights Co. 81A

Lambda Electronics 68A
Langevin Mfg. Co. 72A
Lavoie Labs. 73A
Lenkurt Electric Co. 58A

Magnecord, Inc. 46A
P. R. Mallory & Co., Inc. 6A
Manufacturers Thread Grinding, Inc. 95A
Glenn L. Martin, Inc. 58A
W. L. Maxson Corp. 51A
Measurements Corp. 84A, 94A
Melpar, Inc. 59A
Metal Textile 92A
Eugene Mittelmann 94A
Mycalex Corp. of America 18A

National Union Radio Corp. 59A
New York Transformer Co. 66A
J. M. Ney Co. 87A
North American Aviation 59A
Northern Radio Co. 83A

Ohmite Mfg. Co. 29A

Panoramic Radio Products 79A
Pickard & Burns 72A, 94A
Potter Instrument Co. 39A
Presto Recording Corp. 64A

Radio Corp. of America ..... 32A, 56A & 57A, 59A, 96A
RCA Service Co. 51A
Revere Copper & Brass Inc. 63A
John F. Rider Co. 83A
Robinson Aviation 91A
Rollin Co. 71A

Servo Corp. of America 94A
Shallcross Mfg. Co. 30A
Sheldon Electric Co. 47A
Sorensen & Co. 38A
Spencer-Kennedy Labs. 81A
Sperry Gyroscope Co. 58A
Sprague Electric Co. 16A
Stackpole Carbon Co. 8A
Standard Coil Products Co., Inc. ..... 60A & 61A
Staver Co. 78A
Geo. Stevens Mfg. Co. 40A
Stoddart Aircraft Radio Co. 14A
Sun Radio & Electronics 89A

Technical Materiel 94A
Technology Instrument Corp. 42A
Tektronix Inc. 83A
Telechrome Corp. 84A
Telrex Inc. 94A
L. H. Terpening Co. 76A
Transradio Ltd. 85A
Triplett Electrical Inst. Co. 67A
Truscon Steel Co. 4A

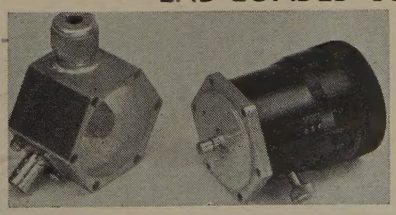
United Transformer Co. ..... Cover II

Wells Sales Inc. 88A
Westinghouse Electric Corp. 59A
Wheeler Labs. 94A
S. S. White Dental Mfg. Co. 82A
Wilcox Electric Co. 65A
Workshop Associates 77A

ONE OF OUR

PRECISION PRODUCTS

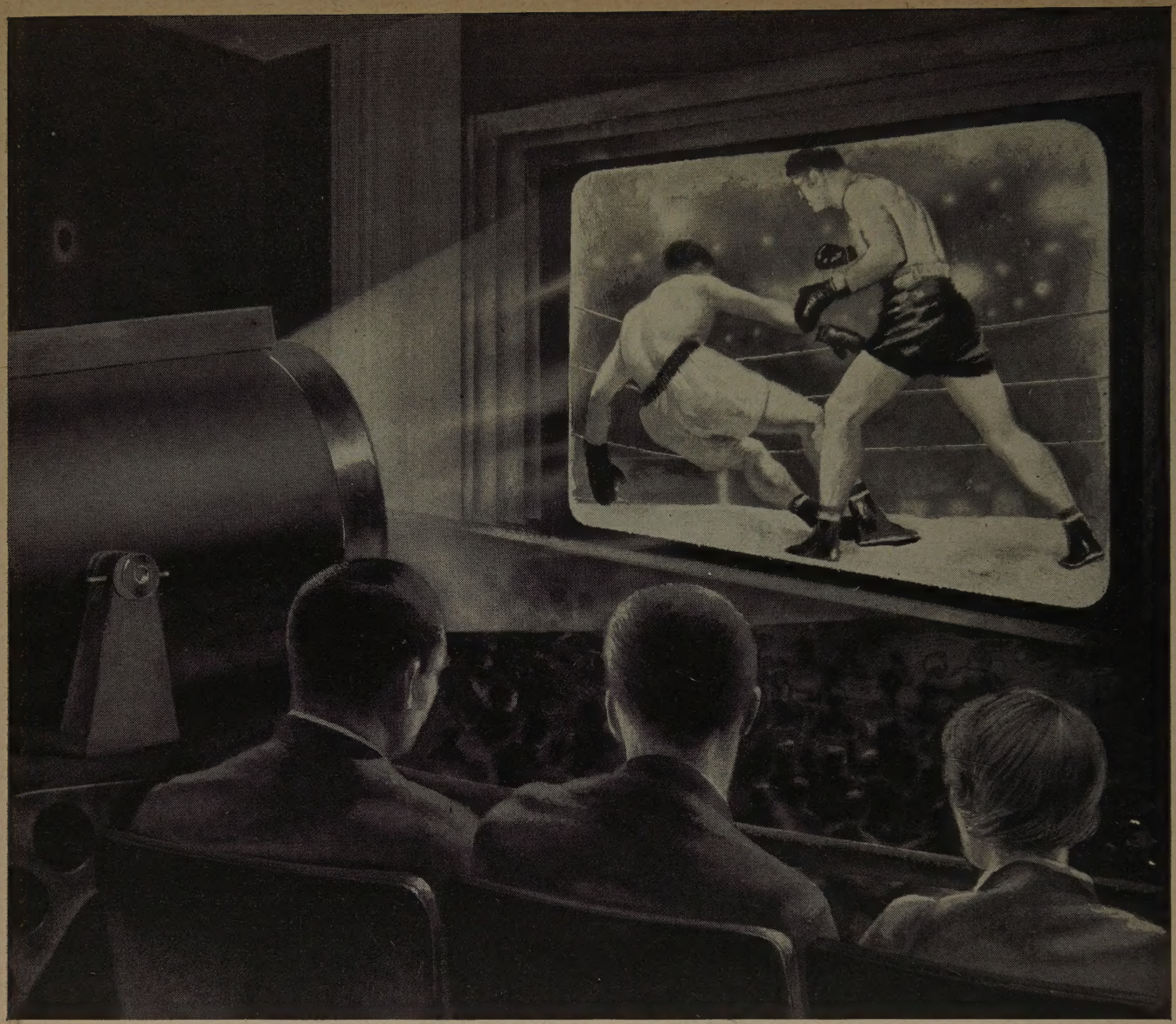
END LOADED COAXIAL WAVEMETER



- Temperature stabilized by use of low coefficient invar
- 1700-2200 MC

MANUFACTURERS THREAD GRINDING, INC.

P. O. Box 66 EATONTOWN, N. J. ASBURY PARK 1-1019



New RCA Theatre Television System projects 15 x 20 foot pictures of television programs.

Giant size Television—"shot from a Barrel!"

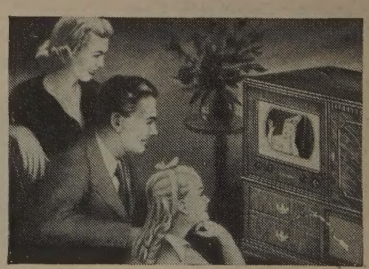
You've seen television. Now you'll see it in its finest form—giant projections of special events, transmitted *only* to theatres on private wires or radio beams to make movie-going *better than ever!*

Success of the system comes from a remarkable RCA kinescope, and something new in projection lenses. The kinescope, developed at RCA Laboratories, is in principle the same as the one on which you see regular telecasts. But it is *small*—only a few inches in diameter—and produces images of high brilliance. These are magnified to 15x20 feet by a "Schmidt-type" lens system like those used in the finest astronomical telescopes.

Because of its size and shape, the new projector is referred to by engineers as the "barrel." It's already going into theatres, where you'll be seeing giant television—shot from a barrel.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, Radio City, New York.



The same research laboratories which developed RCA's new theatre television system also give you big, brilliant pictures on 1951 RCA Victor home receivers.

RADIO CORPORATION of AMERICA

World Leader in Radio—First in Television

they may look alike, *but:* there is only one **C-D**

RELIABILITY

Businessmen call it *reputation* . . . accountants refer to it as *goodwill* . . . production men think of it as *reliability*. Reliability has a dollar-and-cents value entirely apart from the quality and price of the capacitors you buy.

That is why so many leading radio equipment manufacturers insist on C-D capacitors. They know that C-D's extensive manufacturing facilities, reliable service, dependable quality are features that cannot be measured in dollars and cents. Typical of this C-D reliability is the:

"Blue Beaver"* Electrolytic

- Special formation process—developed by C-D engineers after years of research — insures low leakage; good performance at high temperatures; long life at high voltages.
- Low contact resistance between anode and lead wires and negative lead to can, by unique assembly procedure. Contact resistance checked on kelvin bridges and maintained at low value.
- Special separator material prevents breakdowns under most adverse conditions.
- A positive acting diaphragm vent — developed in C-D labs — insures proper venting when needed.
- Special insulator around positive lead eliminates shorts to can.
- Extreme care in assembly to eliminate all contamination plus the finest raw materials obtainable insure a unit free from corrosion.

•

For details on these and other C-D electrolytics write for catalog. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. M12, South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

C-D Best by Field Test!

40TH ANNIVERSARY CORNELL DUBILIER CAPACITORS

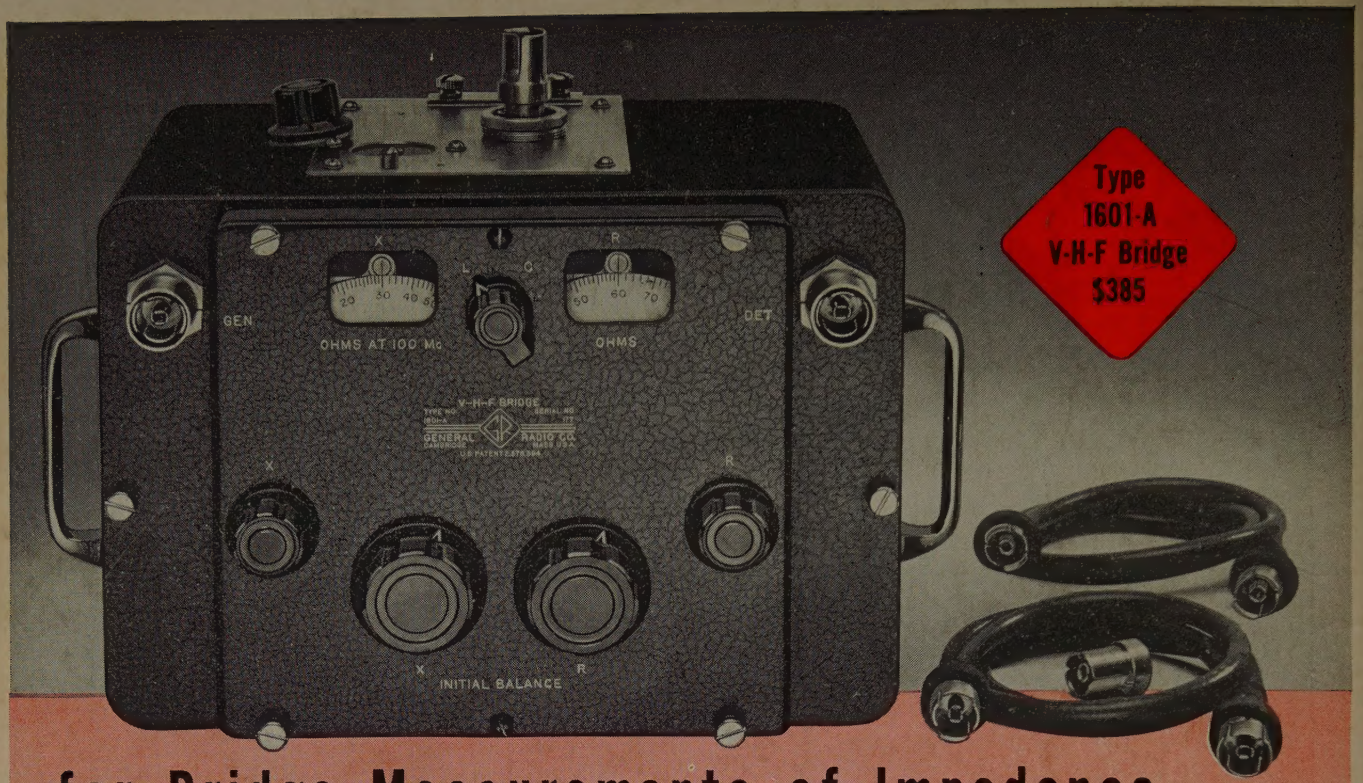
*® 1910-1950

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER

CAPACITORS • VIBRATORS • ANTENNAS • CONVERTERS

RADIART SUBSIDIARY



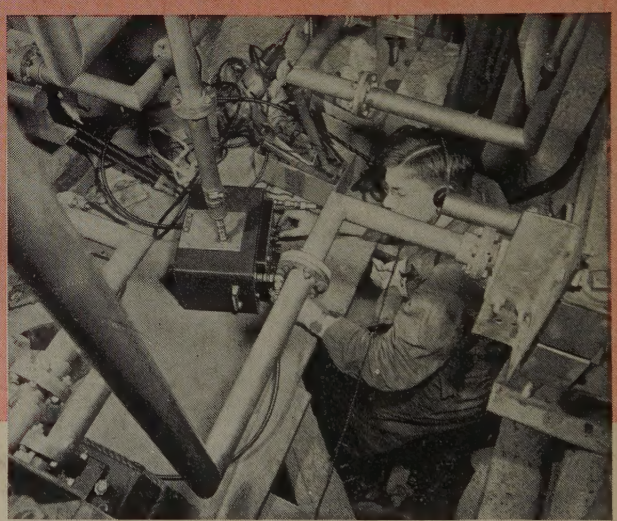
for Bridge Measurements of Impedance

BETWEEN 10 AND 165 Mc

Direct-Reading Resistance Range 0 to 200 OHMS — *independent of frequency except for small corrections.*

Direct-Reading Reactance Range 0 to ±230 OHMS at 100 Mc — *inversely proportional to frequency.*

Coaxial Adapter Supplied for Measurements on Coaxial Systems — *eliminates errors from connecting leads and from residual terminal capacitance. Standing-wave ratio of unknown coaxial system unaffected by terminal capacitance of bridge.*



The Type 1601-A V-F-H Bridge set up to measure the antenna of WCBS-TV on the Chrysler Building, New York City. The antenna consists of 16 radiating elements. Measurements of the impedance variation of an individual element over the operating frequency band as well as impedance measurements of the whole array were made easily and accurately.

THE new Type 1601-A V-H-F Bridge brings to the v-h-f frequencies a means for measurements of impedance of antennas, lines, networks and components, having the same accuracy and simplicity of measurement enjoyed by users of the popular G-R low-frequency Type 916-A R-F Bridge.

With this bridge the range of conventional bridge techniques is extended to 165 Mc. It is equally suited to measurements on coaxial-line systems as on lumped parameter circuits.

It is designed for direct-reading measurements of relatively low impedances, but measures high impedances indirectly and equally well.

For resistance measurements the accuracy is $\pm(2\% + 1\ \Omega)$, subject to correction for inductance in the capacitor used to measure the resistance. A correction chart is supplied with the instrument. The ohmic portion of the accuracy statement varies between 0.1 and 1.0 ohm.

For reactance measurements the accuracy is $\pm(5\% + 2\ \Omega)$. The ohmic uncertainty varies between 0.1 ohm at 100 Mc and 2 ohms.

This bridge is especially suited to measurements of resistors, capacitors, inductors, transmission-line networks and antennas.

GENERAL RADIO COMPANY
Cambridge 39, Massachusetts
90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38